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BODY

AND

ITS HEALTH:

A BOOK FOR PRIMARY SCHOOLS.

BY

E. D. MAPOTHER, M.D.,

PROFESSOR OF PHYSIOLOGY, ROYAL COLLEGE OF SURGEONS;
SURGEON TO ST. VINCENT'S HOSPITAL, ETC.

Twenty-one Illustrations.

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So small a book needs, perhaps, no preface. However, this is the only place its author can state his object in writing it. It was to put the useful facts about themselves in such easy words that boys and girls might learn the worth of a sound body and of a sound mind.

That such a book was wanted has been proved by the fact that the first edition was sold off in three days.

CONTENTS.

THE BODY AND ITS HEALTH.

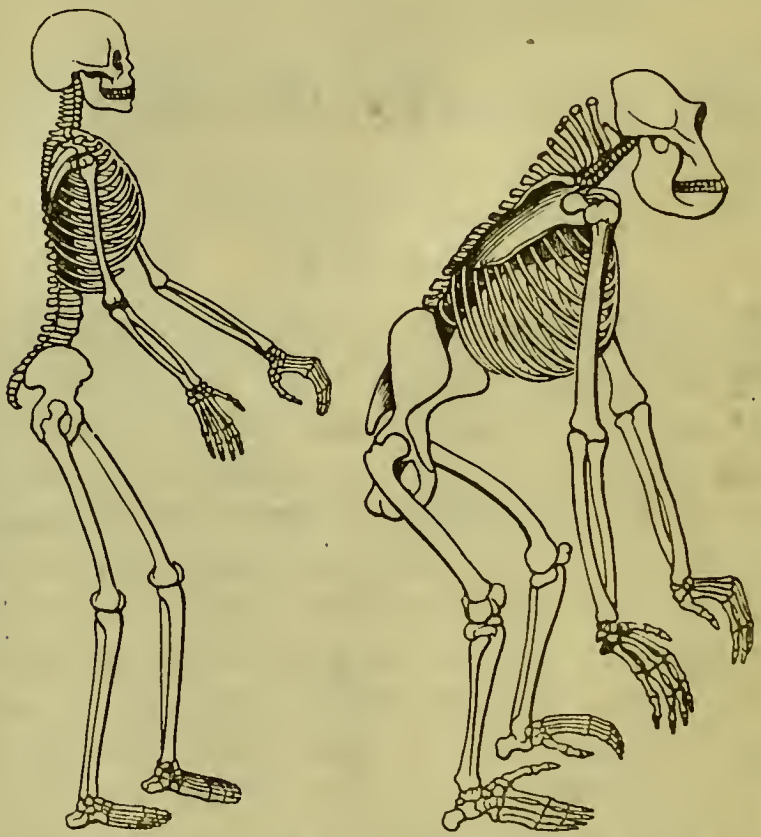
I.—MAN.

MAN wholly differs from other animals in the gifts of speech, reason, and deathless soul. His body, the Creator's most perfect material work, stands in an order for him alone at the head of *Mammals*, that is animals which suckle their young. The study of this body should teach us how good and how wise God is, and that it is our duty to keep ourselves in health.

The erect posture which is natural to man only, is made easy by the neck joining the skull at its centre, the curves of the back-bone, the width of the knees, and the size of the feet. If the surface which touches the ground be much lessened, as when ladies deform themselves with high heels, the body bends forward, the gait becoming unsafe and awkward like that of an ape.

The body is kept straight by strong muscles in the neck, loins, hips, and calves. If the first

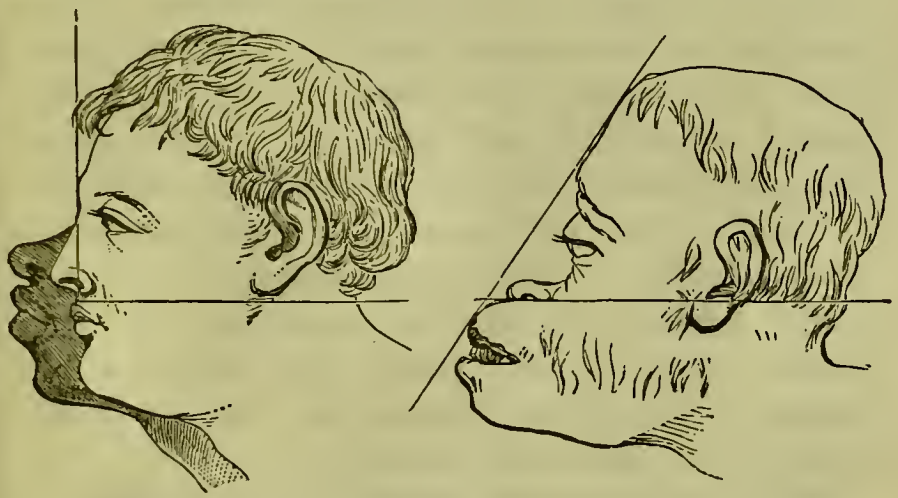
named do not act the head droops as when we nod in sleep, and in one fainting all of them give way. These pictures of the *Skeletons of*



Man and of the Gorilla, shew how that monkey stoops, with his upper hands, for he has four, reaching the ankles, while our two go no lower than the thighs. Our legs join near the middle of the feet, and such firm pillars are thus made that we can stand on one of them.

In man the brain is placed above the face,

in brutes it lies behind it. Lines drawn from the ear to the nose, and from thence up to the forehead, shew this, and the space between them, called the facial angle, is nearly a right



Faces of the Negro, European, and Orang-o-tang.

angle in man, and from one-half to one-third in the monkey. The jaws of a negro go forward a good deal, but his brain is more than twice as large as that of any monkey, and only one-ninth less than that of the highest of men.

Our teeth are all one length and close together; in other animals some are long, some short, as in the dog's mouth, and there are gaps between them as in the horse's mouth, where the bit is put.

Man's body has little natural clothing, or means of offence or defence. By his reason,

however, he can repel his enemies with most deadly weapons, or disarm them with the peaceful pen, and both are wielded by his wonderful hand. He is able to live in any clime by change of food or clothes, while most other creatures perish if taken away from their native countries. He grows for nearly one-third of his life, while most animals become mature in the twentieth part of their's, and in proportion to size their life is much shorter. His body weighs about ten stone, while the various members of other species may differ vastly in weight; for instance, some cart horses are twenty times as heavy as Shetland ponies.

Men all over the world number about a thousand millions, yet they agree so closely in the points we have noted that they cannot be divided into *species;* but there are five chief varieties of the children who have come, as Holy Writ tells us, from common parents, Adam and Eve.

I. **Caucasians,** such as Europeans and Arabs. Their fair blushing skin, high forehead, thin nose, long and soft hair, and great variety of expression, mark this most favoured kind. These white men have settled in every quarter of the globe, and have usually become rulers.

II. **Mongolians,** who dwell in China, Japan, and the Arctic regions. An olive or yellow skin, strong hair, slanting eyelids, and high cheek bones are their main features.

III. **American Natives,** whom a red skin, long skull, and aquiline nose easily distinguish. Their many tribes are quickly dying out; their greatest enemies being spirituous liquors, which they call "fire-water," and diseases brought in by Europeans.

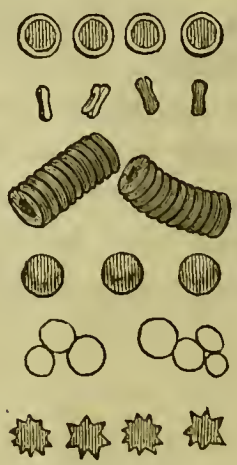
IV. **Ethiopians,** are at once known by a black skin, woolly hair, projecting jaws, a broad nose, long heels, and flat feet. These points do not give any reason why we should not love the negro as a brother, and among the next, are more lowly groups of mankind.

V. **Australia,** and the islands near it, are peopled by Malays and a kind of Negro, nearly as black as that from Africa. The latter have narrow foreheads, flat noses, wide mouths, low stature, and weak legs. It is harder to awaken the belief in God among them than among any other nation on the earth.

II.—THE BLOOD.

Some functions of man serve like those of lower animals and plants, for growth. They are performed by the various organs which renew, spread, and cleanse the blood. We will study firstly these organs, and afterwards those by which we think, feel, and move—powers owned by animals alone.

A cut on the finger or a blow on the nose lets out a red, thick, and hot liquid, by opening the vessels in which it flows. A drop of this blood looks the same all through, but if *magnified* we see crowds of little bodies, the shape of coins, floating in it. These, the red cells,



are here shown on the *flat*, *edgeways*, *piled* together, as they sometimes are, *soaked* in

water, which they suck up and thus become round, and lastly *shrivelled* in a thick fluid. So small are they that 3,000 should be placed in a line to measure an inch, and 12,000 over each other to make a column of the same height. It can be shown whether stains of blood on weapons or clothes have come from man or from other animals by the size and shape of the cells, and in this way murder has been proved. Those of the frog, being four times larger than ours, can be filtered from the thin part. There are no cells in the juices of the lower animals, or in the sap of plants, although these fluids are like blood in use.

The chemist can show a great many things in blood, for instance iron, of which there is more in ruddy than in pale persons, soda, salt, and water to keep it fluid. Its most useful matter is *albumen*, so called from being in white of egg. This nourishes the body, and thickens the blood so that it cannot ooze from the vessels. Arteries hold blood which has food for all parts, and *oxygen* to burn their substance; going back in the veins it is changed, having spent this food and got in exchange the waste stuff, which is mainly *carbonic acid*. The bright red of the one, and dark colour of the other show how they differ.

The blood is kept pure by not taking up

more food than it wants—if an excess is forced on it, the body throws it off, except in the case of fat which is heaped under the skin. We cannot, for instance, thin our blood by taking more water, or thicken it by taking less, for the skin and kidneys will keep the balance. Men's blood varies more with food and habits than with rank or descent; the blood of a prince or of a peasant will be sound or unsound according as he follows or neglects the laws of health.

Disease alters the blood in some cases; in others sends too much or too little to a part. The doctor can change its quality or supply, but now he rarely bleeds, for many diseases kill by weakness, and if the fluid be impure drawing off a little does not improve the rest. Want of open air exercise and of meat diet may make the blood of girls so poor that they get a green colour. *Catching diseases* increase in the blood; if a drop of small-pox matter was put into yours, and you had not been made safe by vaccination, enough of that poison would grow to spread the disease to every man in Europe. As these diseases, therefore, ferment, they are called *zymotic*. They enter our blood most easily when we are fasting, so that there is safety in good food. (See page 105.)

The uses of the blood are—1st. To repair our flesh, brain, and other parts which in doing their work lose substance. We cannot move or think without some of our muscle or brain being burned by oxygen, and this too the blood-cells carry from the air in our lungs. Thus the Creator—

"Builds life on death—on change duration founds."

Our blood, then, is a kind of fluid flesh and bone and brain, and during a year it brings over a ton of material from the food for building our body.

2nd. To carry to the lungs, skin, and kidneys, the burned stuffs, such as water, carbonic acid, and *urea*, which if not thus got rid of, would soon choke our vessels and poison our blood.

3rd. To spread the heat given out by the burning of our substance, and thus we are always kept at a *temperature* of 100 degrees, there being means of cooling besides. In cold-blooded animals, such as fish, the cells form only one-twentieth of the blood; in us they form one-eighth.

Clotting is that special and most useful power by which blood divides into a solid and a liquid part. If a water pipe bursts the plumber only can staunch it, but the clotting

of blood plugs a wounded vessel, and saves us from death. It is caused by the fibrin, a thready substance; for if this is taken out by stirring or whipping, the blood remains fluid. If fresh blood be frozen it will clot wher thawed a year after. Death by lightning and by some other sudden ways, prevents the clotting. The thin part of blood is called *serum*, and this oozes out in dropsy and in cholera, leaving the rest so thick that it cannot flow. The quantity of blood in a man is about $1\frac{1}{2}$ or 2 stone, or 2 or 3 gallons, a good meal raising it to the greater amount. Skilful surgeons have saved the lives of many women bleeding, by causing the blood of their husbands, or that of a generous friend, to flow into their veins.

III.—FOOD HEATS US.

A man weighing 10 stone, or 140 pounds, consists of about 100 pounds of water, 14 of *gelatine*, 12 of fat, 9 of albumen, and 5 of salts. The food which goes to renew these is of two kinds—First, that which having much carbon is the fuel of our body; and, second, that which feeds our flesh, brain, and other parts with its albumen. The heat-foods are

fat and sugar. Starch changes into sugar as it is chewed. When people eat too much sugar, for instance, the negroes while the canes are being cut, it is not all burned off, but heaps up in the body as fat.

Potatoes, having little else than starch, are poor bulky food alone, but with milk, or fat meat, nothing could be better. Town people who use more butter would prefer lean meat. Rice and sago, still purer starch, are heating enough for Southerns, but the Arctic native will make a meal of some pounds of fat pork, a pint of oil, or a couple of pounds of candles. Too much sweet or fat food will make one over-stout, the more so if he is lazy besides. To gradually lessen the supply and work it off by exercise is a sure and safe cure.

Liquors made by *fermenting* grains and fruits are thought to be heat-foods by those who on a journey take a little spirits and water or beer, as it warms them and keeps off hunger. Such drinks taken now and then may cheer us, but their daily use hurts us, and all know that the drunkard destroys body and mind, and ruins those who depend on him. Much spirits if taken suddenly kills the brain at once, and this noble part, as well as the stomach and liver, suffers by small doses, if taken often. There is Divine sanction for the use of wine,

which serves the sick or sad man, and makes friends happy; yet no one can deny that the good strong drinks have done weighs as nothing against the evil their abuse has wrought. A man who would as soon cut off his hand as hurt his wife, will choke her when he is mad from drink; but he must account for such madness when judgment comes.

All people crave warm drinks, and tea, cocoa, or, better, boiled milk are good and pleasant. Too much tea hurts us, and it is a dear food, for it does not make us strong.

Water, if pure, is the best drink. Lakes and rivers which have not flowed through cities or manured lands give pure water. For instance, that of Loch Katrine, which Glasgow gets, has only three grains of solids in the gallon, and that of the Vartry in Dublin four grains. The water from stagnant canals or ponds is unsafe. Wells or pumps, if away from houses or foul places, give a fair water, but those in cities are most dangerous, even if they give a water bright and nice in taste. Diarrhœa and cholera have been often spread by such water, which gets more foul and scarce in summer. In all towns, therefore, there should be works to carry water from a safe source, and the average cost is often but £1 per head. Lead pipes or cisterns are danger-

ous if the water stands in them, but when one-twentieth of tin is added a safer material is formed. Where there are pipes, water-butts should never be used.

Soft water is more wholesome than that made hard by lime, and far better for washing, cooking, or making tea. Lime is shown by its curdling soap. Impure water is made safe by boiling, which destroys animal matter, and it may be then aired and cleared by a charcoal filter, which costs but a few shillings. In every ship there should be filters, or fresh water should be *distilled* from the sea. Water to be fit for drinking should be clear, without taste, smell, or much colour, and not over hard.

Fruits, such as the lemon and orange, and vegetables, especially those eaten raw, give the blood potash salts, and without such food scurvy arises. Before this fact was known to doctors, thousands of sailors died yearly from that disease; now it never arises unless a dishonest druggist sends on board some useless *imitation* of lemon-juice.

IV.—FOOD FORMS US.

The foods which build up our bodies contain some form of albumen, and gelatine is added in meat and jelly. Meats are the best of all

foods, for they yield one-fifth of their weight of albumen, and are easily digested. The flesh of oxen and sheep which, in South America and Australia goes to waste, would feed our people here, if steamers could carry the animals with profit, or if preserved meat or its extracts became favourites, or were sold at a fair price. Beef from a stallfed ox may be unwholesome from fat, and mountain mutton is nicer and more easily digested than that of a sheep which has fed lazily over a small plain. Our teeth, stomach, and bowels are much more like those of flesh-eating than vegetable-eating animals, and men who live alone on rice or potatoes do not reach their full vigour of mind or body. In some northern climes none but animal food can be had. Those who object to eating flesh have gone so far as to say that men may follow the ways of the animals they use, from mutton become sheepish, from bacon piggish.

Cooking makes meat more tasteful and wholesome. Roasting hardens the surface of a joint, so that the juice is kept in. If meat is put at once in boiling water the same happens, and the flavour is good. If broth is to be made the meat should be cut up fine, and the water slowly heated. The water in which a joint has been boiled should never be thrown away, for a clever cook will add celery or onions and

make a good soup. Girls who learn cooking will, when they become wives, make their husbands' homes more pleasant than the public house.

Meat should be sound, and from no animal which had any spreading disease. Pigs often have the measle-worm in their flesh, which is here shown. It is the young of the tape-worm,

which will grow in us if we eat meazly pork. In Germany hundreds have died from eating pork with the *trichina* worm, but no pig killed in the United Kingdom has ever shown it. Every farmer should check disease in his stock, by keeping the healthy from the sick, and by calling in the cattle-doctor early. The cure of animals should be taught in every city and practised in every town.

Peas and beans are cheap and nourishing food, and if ground, make good bread or stir-about. They contain a matter like the curds of milk, so that cheese may be made from them.

Mixed Diets, which give us starch from vegetables and albumen from meat, are the best. If fed on the first only, men get weak, and a pure meat diet would give us scurvy. Eggs and milk which nature offers, and bread which civilized nations mainly rely on, are mixed foods. The yolk of the egg has fat, the great heat food, and the white is the model of all foods. In milk there are butter and sugar to warm us, *casein*, a kind of albumen, and lime salts, which increase as the young wants them to harden its bones. If a mother unhappily cannot suckle her child, cows' milk must be given, and it may be made better by adding one tablespoonful of cream, three of water, and a teaspoonful of sugar to each wineglassful of it. This should be warmed and kept in vessels perfectly clean, for everyone knows how easily milk is soured, and then it becomes dangerous for a baby. Adding water, or worse stuff, to milk which is sold may hurt, or even kill babies. The milkman, brewer, or druggist who steals our money and our health by bad milk, beer, or physic, should be sent to prison and hard labour like felons. In many cities there is a public chemist for detecting bad food. Buttermilk is good food, and there is none cheaper.

Bread feeds our tissues with *gluten* or vegetable albumen, and keeps up our heat

with starch, but it becomes more heating when butter is added. Spongy or light bread is most easily acted on by the saliva, stale bread digests most easily, and brown bread is most nourishing, and tends to keep the bowels open.

V.—HUNGER AND THIRST—THE RULES OF DIET.

Hunger is a great spur to make men work for their daily bread. It depends on the waste of our tissues, and, therefore, the man who has mowed a rood of meadow since daylight will make a more hearty dinner than one who has lain in bed half the morning. Another feeling in the stomach tells us when enough has been eaten. Want of food for a few hours causes appetite, but if none be had for a day or two, faintness, coldness, shrinking of the substance of the body, and a wild and wandering mind, denote starvation. Death ends such suffering about the 5th day, or when the body has consumed two-fifths of itself. Cases of long fasting are not to be believed in. The Welsh girl died rather than confess the deception. Old persons, like slacked fires, may smoulder a long time without food. As Sir D. Corrigan proved, fever always follows famines. Thirst causes a quicker death than hunger, owing to

the thickening of the blood. This calamity sometimes befals shipwrecked sailors, or travellers in the desert.

Quantity of food varies as much as quality. Our soldiers' diet contains about 18 ozs. of starchy matter, 4 of albumen, $1\frac{1}{2}$ of fat, and $\frac{3}{4}$th of salts. These cost about 7d., while the pauper is fed in the workhouse for 3d. Those who can earn ever so little need not seek this refuge, for 2s. will buy the following provisions for the week in England—bread, 9 lbs.; oatmeal, 1 lb.; meat, $\frac{1}{2}$ lb.; bacon, $\frac{1}{4}$ lb.; vegetables, 4 lbs.; skim milk, $3\frac{1}{2}$ pints; butter milk, 3 pints. In Ireland such a poor man would go in for more potatoes, in Scotland for meal or peas.

Meals—three in number, are usually enough. Breakfast should be eaten soon after rising; as to material, no one who has stirabout and milk is to be pitied. Dinner is taken by men in various ranks at all hours from noon to 8 p.m. On large farms, and in factories, good dinners may be given, if all the workers join in a mess, at much less cost than if each provided for himself. "After dinner sit a while," is a good old rule. Supper should be had at least two hours before going to sleep, for the stomach wants its rest at the same time as other parts. Children, in whom waste and growth are most

active, should be fed much oftener, but never till the food last given has had time to be digested.

Indigestion, with all its queer feelings about the stomach, heart, or head, is common among the poor from quality of food; among the rich from quantity. A clever doctor will soon cure either if his advice be had early and then followed. He will show that a man who stuffs himself with more food than he can digest, is like a stoker who would choke his furnace with coal, and thus stop the engine it should work. A restless night, and a headache and want of appetite next morning, punish him who takes over night bad food, or too much good food—who

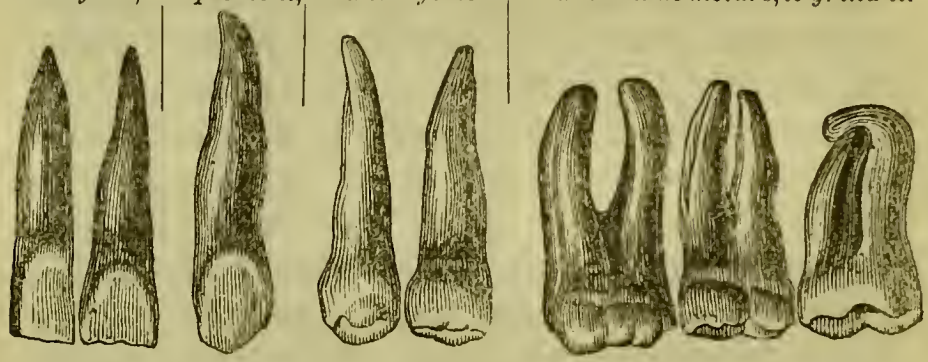
"Gets him to rest, crammed with distressful bread."

VI.—HOW FOOD IS DISSOLVED.

Put in the mouth by the hands and lips, the food is cut and bruised by the teeth, the lower jaw moving in every way, so that we chop like a dog, and grind like a cow. The tongue and cheeks roll it about most nimbly to have it well chewed and mixed with saliva.

The teeth of a child, 20 in number, fall out about the 7th year, and the 32 which then appear are meant to last during life. They rarely do so owing to general ill-health, hence the great gains of the dentist. The four back

teeth do not cut out till we are "of age." On each side of each jaw there are

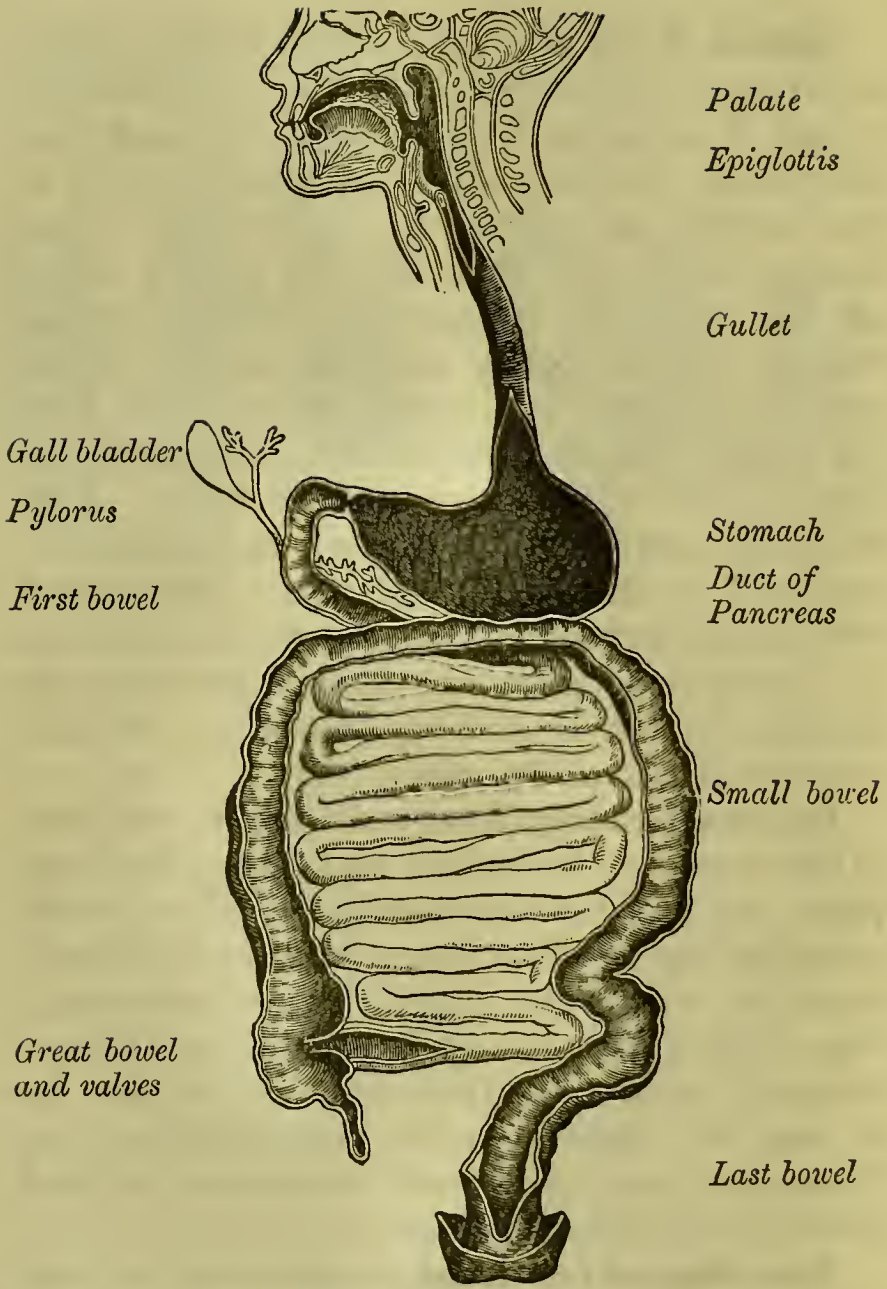


The upper jaw has a larger curve than the lower, so that its teeth overlap those of the lower. Thus they sharpen instead of blunting each other, which they should do if their edges met. Enamel, as hard as flint, covers the crown, or part beyond the gum. If children chip it off by cracking nuts, it never forms again, and the tooth soon aches and rots. Ivory forms the body, and the fangs are set in their sockets by bony cement. A hollow lodges the nerves, and if the air gets to them we suffer toothache. Our teeth are best kept clean and sound by brushing with soap and water, or powdered charcoal. Tooth picks are very good, yet ladies never use them. False teeth are usually made from china, but a tooth pulled from one person has been known to grow in the socket of another.

Saliva is the fluid poured out by the glands in front of the ear and under the jaw (marked 1 and 7 in the picture on page 36), and that below the tongue. It flows when food is in the mouth, or when we see or smell it, for then "our mouth waters," the glands being on the watch to be useful. Saliva contains water, *alkaline* salts, and an active matter which changes the starch we take in food to sugar. Such food should, therefore, be kept in our mouth longer than meat. This fluid also soaks through each mouthful, and makes it more easily swallowed. After food has been chewed, and given us the pleasure it is meant to give, we pass it towards the gullet, the *tonsils* having poured out a fluid to make it slip down easily.

In swallowing, food is shut from the back of the nose by the palate, and from the windpipe by a lid called the *epiglottis*. If a morsel goes the wrong way, coughing usually expels it; if not, the finger should be used to hook it out. The gullet slowly forces the food to the stomach, which has thus time to prepare for it, and we should never bolt what we eat. From the way a cow feeds we learn that food does not merely drop down.

The digestive canal is shown in this cut, the names of the various parts being printed opposite to them:—



Its whole length is from 25 to 30 feet.

The stomach lies below the midriff, and is covered in by the breast bone and lower left ribs. It is an oval bag, holding easily a quart of fluid, which could not pass on till a round valve, the *pylorus*, opened. This watchful doorkeeper will only let through digested food, and if we eat too much the surplus is usually cast up again. The stomach can move freely enough to rock the food to and fro, and to urge it in a circuit from the gullet to the bowel. It has a polished surface to make these motions easy, then a fleshy coat, and lastly the mucous lining which can be traced through all hollow parts. On this surface there are pits, and thousands of tubes which pour out, when food comes in, gastric juice. This contains water, *hydrochloric* acid (spirits of salts), *lactic* acid (that of sour milk), and the ferment, *pepsin*. The last, from the calf's stomach, we know as rennet.

Digestion is the solution of food by this gastric juice, which changes flesh, cheese, and such matters, in two or three hours, into *peptone*, which the veins suck up to renew the blood. Enough juice is poured out to dissolve the amount of food wanted by the system; any excess is, therefore, not digested, and does harm. Many of the above-named facts were proved on persons who had got wounds of the

stomach. The time wanted for various foods was also settled; for instance, a meal of pig's feet left the stomach in one hour, fish in three, and veal took four hours. Fat is slowly digested, and the husks of fruit, and the springy matter in arteries and joints of animals, defy the stomach altogether. Rest of the body and calmness of the mind promote digestion.

VII.—HOW FOOD IS SUCKED UP.

Water, and medicines dissolved in it, leave an empty stomach in one minute, a full one in 40. Too large draughts of cold water may kill by thinning the blood, when the skin and kidneys are not in perfect order, or by shock to the nerves, which abound near the stomach. Peptone, or dissolved food, is taken up slowly by the veins of this organ, and fat, starch which may have escaped the saliva, and refuse, pass into the first bowel. Here, the liver pours in bile, and the *pancreas* its fluid. The bile urges the bowels, and makes the fat more easily taken up, but it is chiefly refuse of which the liver rids the blood. The pancreas, a gland, nearly as big as one's hand, lies across the upper loin bones. Its juice makes the fat of the food into a kind of milk called *chyle*, which is readily sucked up by the *villi*. These are hair-like

bodies, which take up the chyle, and pass it through tubes, called *lacteals*, to the thoracic duct. This duct discharges it into the vein under the left collar bone. Above the bowel the lacteals form small glands; they are blocked in scrofulous children, and wasting ensues, as no fat can pass, so the food "goes into an ill skin."

The intestines have folds to prevent the contents passing too quickly, pits which pour out fluid, and gland cells. Of the last we do not know the use, but they are diseased in that kind of fever which bad sewers, and foul water spread (see p. 18 and 107). The greater bowel, six feet long, passes from the right haunch, where valves will not allow its contents to pass back, to below the left haunch. Fleshy fibres give worm-like movements to the bowels, to pass on the contents and expel them when all the food useful to the blood has been taken up. Blood is then renewed with albumen and sugar, which enter by the veins of the stomach, and with fat which enters by the lacteals. Besides these, lymph, a clear fluid from all tissues, passes into the blood by special vessels, which go through glands such as those at the side of the neck and armpit. Cells, to renew those of the blood, are found in both chyle and lymph, and thus goes on the profit and loss account so well balanced in the system.

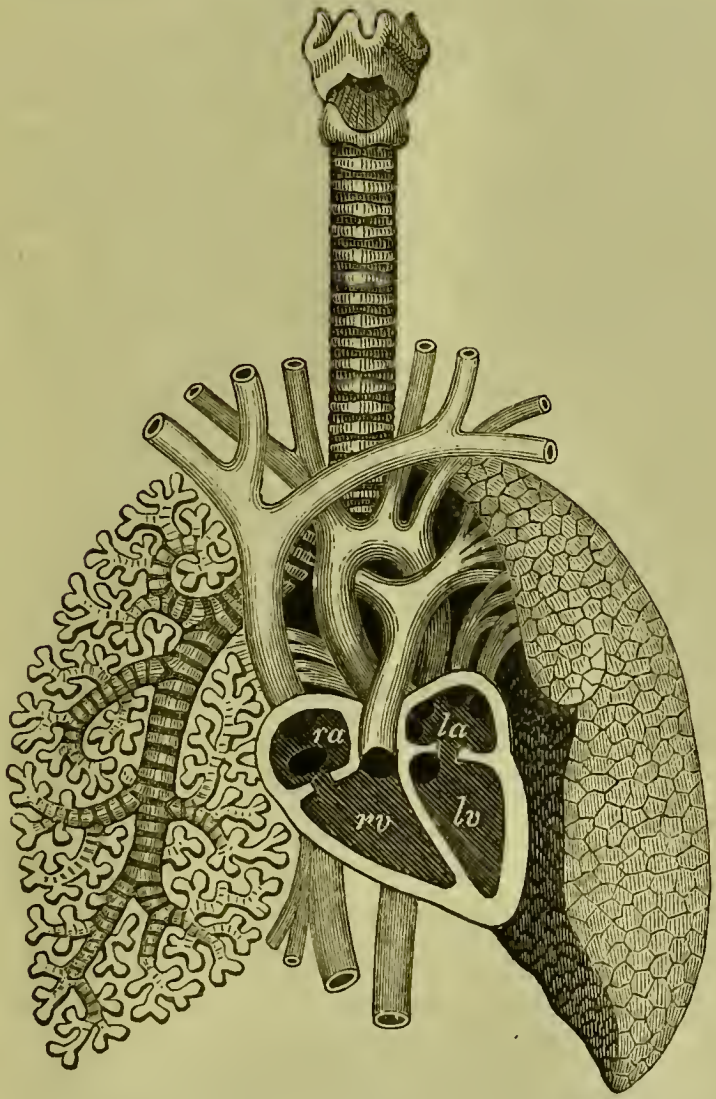
VII.—THE HEART.

Rich as blood is, like money it is no use till spread, and it therefore goes the following round. Two *veins* bring it to the right *auricle* of the heart; thence it flows to the right *ventricle*, which pumps it to the lungs. In these organs it loses its dark colour, being made pure by air, and is carried by four veins to the left auricle. From this chamber it passes to the left ventricle, which is strong enough to force it through the *arteries* of the whole body. They end in *capillaries*, in which the blood gets spent and spoiled, and from them it reaches the veins which pass it back to the heart for another round. This course, called the Circulation, was shown by Harvey, in 1619; but, 20 years before, that wonderful man Shakspeare described the way the blood goes in fainting, and what should not be done then:—

> "Why does my blood thus muster to my heart,
> Making both it unable for itself,
> And dispossessing all my other parts
> Of necessary fitness?
> So play the foolish throngs with one who swoons;
> Come all to help him, and so stop the air
> By which he should revive."

The cut will explain what has been said.

The heart is cut down, so that its four chambers, and the vessels which open into them may be seen.



The Windpipe, Lungs, Heart, and Great Vessels.

The heart is larger than the fist, and stretches from the right third to the left sixth rib; a strong smooth bag protects and fixes it. It is a hollow muscle in two halves, one pumping the blood to the lungs, the other through the body. Each side has a thin bag above and a fleshy one below. The four rooms, two auricles and two ventricles, are seen in this diagram. Each holds about a wine-glassful of blood. The left side is very thick, having to work the blood all through the body. The Rev. Dr. Haughton states "it has eight times the force of the most powerful engine" in proportion to weight. Both sides squeeze together or *contract* at the same time, and this motion occurs every second, so that during an ordinary life there are three thousand millions of beats without a break. This most perfect of machines has little doors or valves, which will not let the blood go out of the right course. The opening from the right auricle to the ventricle is guarded by three flaps (*tricuspid valve*); the same place on the left by two (*mitral valve*). On the right there is some leakage, so that bursting of the heart is rare indeed. At the mouth of the *pulmonary* artery, which leads to the lungs, there are three little pockets; now, the weight of the blood throwing it back, it catches in these, and they close the opening. The *aorta*

or main artery has similar valves, but *rheumatism* often puts them out of order.

Two sounds are heard if we put our ear over the heart, the first and longer as the blood is leaving the heart, the second as it falls into the pockets of the two arteries. The hand may feel the heart striking the ribs as it contracts, and if this be quicker and stronger than usual it is called *palpitation*. This is not always a sign of disease, but in hippish people is often an effect of the mind on the nerves of the heart. When shame makes the heart send more blood to the blushing cheek, and when fear almost stops it, they act on its nerves. A cheery mind acts on this organ usefully, and a sad one injuriously to our health. However, poets err when they call the heart the seat of the passions. Our will cannot stop the heart; but one Colonel Townsend, of Dublin, could stop his, and after many escapes he lost his life in the act. Cases of trance and burial alive are seldom to be believed in.

The pulse or beat is most easily felt in the artery above the wrist, and it occurs there one-seventh of a second after the heart has acted. Sixty beats a minute is a common rate in old people, but at birth it is twice that. The heart beats more slowly when we sleep or lie down, and more quickly when we take food or exercise.

A Artery of arm.
C Carotid artery.
1 and 7 The salivary glands.
2 Great muscle of neck.
3 Adam's apple.
4 to 12 Muscles of face.

IX.—THE VESSELS.

The aorta or artery from the heart, is about an inch in bore in us, and over a yard in the whale. After giving off branches for the head and arms it curves to the back of the chest, supplies the organs in the trunk, and ends at the loins in two branches for the haunches and legs. Such arteries break into smaller and smaller ones, which often join in loops, so that if one vessel is blocked at a point the blood may reach it by others joining lower down. How freely they join in this way may be seen from this picture of the neck and head.

The heart throws the blood into arteries with a force equal to 3lbs. weight, yet the course of the blood is promoted by their being elastic. Being stretched they react on the blood and keep a steady flow like that of the fire-engine hose, which is made of India-rubber. Still, scarlet blood jets from a wounded artery, and unless some one has the presence of mind to press a finger on it, the loss may be fatal. Sudden strains of the limbs may crack arteries, and lead to swellings on them, which are called aneurisms.

Capillaries are named after hairs, but they are fifty times finer, many only letting through a single blood cell. So closely woven are they

that you cannot stick in a pin without wounding some.

In the *frog's web* (here shown), the minnow's tail, or the bat's wing, which are *transparent*, you can see the wonderful circulation of the blood. The cells rush in by the artery, pass slowly through the capillaries, staying to nourish the tissues and take their waste, and then crowd away by the vein. This exchange sucks on the blood, and in plants such is the only force for moving the sap. In animals the flow is controlled by the brain and nerves. If you anger a turkey-cock how full of blood his comb becomes!

Veins collect the blood from the capillaries, and the smaller run together, until they make but two, which open into the heart. They are thin, knotted from valves, and often near the skin, as you can see on your hand as it

hangs near the fire. Muscles when acting press onwards the blood of veins. Too much standing or tight garters often swell and spoil the valves of the veins in the leg; if they burst the bleeding is fierce. Raising the leg and pressing the finger on the hole will, however, stay it. A deep breath helps the flow in the veins, and if one is wounded it may suck in air with fatal effects.

Health and life depend so much on the due motions of the blood that we should never check them. A tight necktie, or holding the breath, during a long violent effort, has caused many a fit, for thus the vessels of the brain easily burst. Many a lady has got a weak heart, fainting fits, short breathing, a big liver, a waist and a temper like a wasp, or, what she might think worse of, a red nose, from tight stays.

X.—THE LUNGS.

If we were to stop breathing for five minutes we should die; this act then clearly concerns life, and as clearly concerns health, if we breathe too little or impure air. The mouth, or better the nose, for then it is warmed, lets in air which passes to the wind-pipe. This, shown on page 33, is a flexible tube six inches long, and nearly one wide, and it ends in a branch for the root or fixed part of each lung.

From thence the tube breaks in twos and twos till they get as fine as hairs. The air-cells are pits leading off these final tubes, and round them and between them are the capillaries with blood to be aired. The space around the air-cells is filled with spongy tissue, and the lung thus made up is clothed with a smooth membrane, the *pleura*. Another part of the pleura lines the chest, so that the play of the lungs within it is made easy. The air passages are lined by mucous membrane, which is often the seat of colds and *bronchitis*. About 150 millions of little hair-like bodies on its surface waft the air to and fro, and expel dust as well as the slimy matter we cough up. The figure on page 33 will give some idea of the lungs, and those of the sheep, the lights, may be easily studied. They are pink, however, while ours get grey from dust and smoke in the air. Once lungs have breathed they get so light and springy that nothing can squeeze out air, and they always float on water.

We draw in air by the midriff or *diaphragm*, a fleshy partition between the chest and belly, going down and by the ribs, which are slanting, being raised and turned out (see fig. on p. 8). The chest being then enlarged the outer air rushes in to fill the space. To fill the whole lungs, which is a good thing to do

now and then, the muscles from the shoulders may pull out the ribs.

We expel air by the recoil and muscular power of the lungs, and by the organs below the midriff being pressed up against it. Coughing and sneezing are sudden acts of the midriff, and may expel intruders in the air passages, such as tobacco smoke or snuff. When we sigh we take in air freely to make up for having taken too little while the mind was fixed on some subject. A full stomach will not let the midriff move freely.

We breathe about sixteen times a minute, and take in about twenty cubic inches, or nearly half a pint of air each time. With effort much more may enter; thus a man after the deepest breath can often expel 220 cubic inches. The chests of small or light men, and females squeezed in stays, will hold one-third less. The following case shows that death would result from stopping the motions of the chest. Some artists wishing to mould the fine figure of a negro, encased him in plaster. As it set he could not breathe or cry out, and would have died if one who knew the actions of the human body had not come in and broken the cast. Fishes breathe the air in water, and die in water from which it has been forced by boiling. Frogs swallow air like food, and take it in also by their skin.

Air consists of one part of oxygen to four of *nitrogen*, a gas which merely dilutes the active one, which by itself would excite and kill us. The vapour of water and a trace of carbonic acid (the food of plants) are also in air, the latter increasing in close rooms. Country and sea airs have a gas called *ozone*, which keeps them pure and bracing. In some towns it never can be found, so that everyone should have a country walk at least once a week.

Breathed air is changed in three ways: 1st. It has more water; of a cold day it makes a cloud from our mouth, and in a crowded room water soon runs down the window panes—in such a place one may faint, not from heat, but from want of fresh air.

2nd. It has a hundred times as much carbonic acid. This is shown by breathing through a quill into a vessel of lime-water, which will turn white, from chalk being formed. Young active men give out much more of this gas than the old or feeble. The entire amount of 24 hours' breathing would contain 8 ozs. of carbon—the body we know as charcoal or soot. This gas, although heavier than air, mixes through it, else all animals on the surface of the earth would be poisoned.

3rd. It loses one-fifth of its oxygen; for this is seized by the red cells, and burns the

carbon and hydrogen of the tissues. The results—carbonic acid and water pass to the lungs in venous blood, and thus escape. The exchanges of the gases in the blood and in the air are not hindered by the thin coats of the vessels in the lungs.

XI.—HOW WE KEEP HOT.

The heat of our body stands at 100 degrees, whether we are in Lapland, with a *temperature* 80 degrees below the freezing point, or in India, where it may be 80 above it. The self-produced heat is due to the burning of our tissues by oxygen, that busy-body gas of which we have to say so much. By greater exercise or breathing we become hotter, and the blood spreads heat even to parts not acting, as the warming pipes of a building do. Our body soon warms up the bed, even on the coldest night. Fat and sugar in our food are the chief fuels, and in summer they go to make us stouter, as less burning is needed. Old or very young people have less power of making heat, and want, therefore, thicker clothing; children cannot be made hardy by lighter covering. The poor, with little food, are best helped by coal and blankets during winter.

We cool by giving heat to the air around, and to *perspiration*. The black skin of the negro absorbs heat, and the vapor going off keeps him cool. A moist hot air is hard to bear; but when the air was dry, men have stopped in sculptors' ovens hot enough to fry a chop. Warm houses are very good if they are not made so by shutting out all air that is fresh, and shutting in all that is foul. With brisk fires every room, and with hot water pipes every factory can be heated, while they are kept wholesome and airy as well.

Cold shrivels the skin and drives blood to the inner parts, to their great risk, if bathing has not given the habit of bearing it. Great cold makes a man sleepy, and then kills him.

"On every nerve
The deadly winter seizes, shuts up sense,
And o'er his inmost vitals creeping cold,
Lays him along the snows, a stiffen'd corse
Stretch'd out, and bleaching in the northern blast."

Thus died some of Captain Cook's sailors, who did not heed the warning, "Whoever sits down will sleep, and whoever sleeps will wake no more." Chilled toes or ears should never be warmed too quickly; but the blood should be brought back by gentle rubbing. Woollen stockings are the best cure for chilblains.

Catching cold is usually due to checking

perspiration from a skin which is not made hardy by daily bathing. Changing wet clothes the moment we cease from work or exercise will often save us; so will a hot bath, or a warm drink at bed-time.

Light is needed by us as much as air and heat. If clay be heaped on a potato the stalks and leaves get white, and the man who lives under ground gets pale instead of ruddy. Darkness helps to fatten oxen or fowl if they get plenty of food, but makes them unsound as well. Want of light promotes *consumption*, so that even if our curtains or carpets fade it should be let in. The bad habit of making windows small and few arose when statesmen were so foolish as to tax them. Windows if black from dirt, or pasted over with paper, are worse than useless.

XII.—THE WORTH OF FRESH AIR.

We have learned how needful for life and health pure air is, yet, in the gallery of a theatre, nine times, and in a crowded school, eight times the fit amount of carbonic acid have been found. And what is worse, there is even a greater increase of animal matter in

close places. In the air of a railway carriage twenty-five times as much of this was found as in the open air. How nasty it is to breathe air fouled by others, yet people do so who would refuse to drink from a cup a friend had used. Our nose tests air well; if you leave your bed-room tightly closed, and go back after an hour's walk in the morning air, it will feel quite sickening. Yet by good size, a fireplace, and in summer an open window, we may have as good air in our room by night as by day.

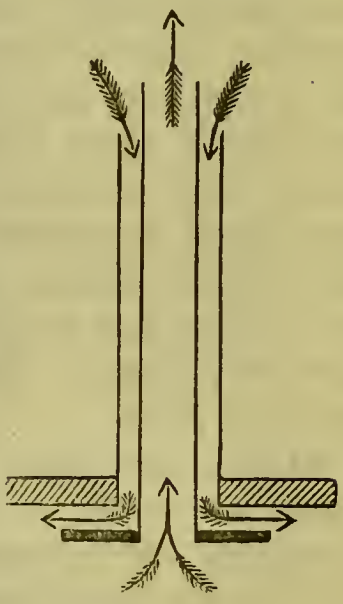
Smoking makes a room smell badly for hours; this nasty habit then annoys others, and is bad in the following ways:—It sickens the stomach, fouls the breath, stains the teeth, weakens the heart, and worse than all makes one lazy.

Drowning, choking, and the burning of charcoal in a close room, kill by robbing the blood of oxygen and filling it with carbonic acid. Taken into the stomach in bottled ale or soda water, this gas is harmless; but if breathed, it poisons the blood, and the person gets senseless and dies. A man kept in an air-tight room would die as surely, but more slowly. In 12 hours 123 were thus killed in the Black Hole of Calcutta; and in 6, 90 persons in the cabin of the ship Londonderry.

The stupid captain shut the hatches, and there were only 7 cubic feet of space for each person. Our Courts of Justice are fearfully close, but now that a judge has been killed by the bad air, there is some chance of their being made less hurtful. The monkeys in the Zoological Gardens are much more healthy since their houses were better aired. Any body who has a penny to spare should go now and then to these grand gardens, in a splendid park.

Airing of rooms is best done by windows, doors, chimnies, or in some cases by special openings. Windows ought always to open at the top, for then heated air escapes and draught is avoided. Doors let in air at the bottom, and let it out at the top chink, as you can show by the way the flame of a candle is blown. Chimnies let air escape or draw it up if the fire is burning. They never should be stuffed in summer. Even in the coldest weather every window and door should be opened for a while to give thorough airing. The good points are, that the air which enters shall neither be too warm nor too cold, and shall come in without draught. Bricks pierced with small holes, which sell for 3d., should be built in over every window, for the bad air gathers near the ceiling. In rooms where

many people work the best *ventilator* is that shown in the cut. Set in the roof, it lets up the foul air in the centre, and lets down, without draught, the fresh. It acts well if put over the gas-burner. Rooms in which gas or candles are used want more air than day rooms, for oxygen is quickly consumed. The setting up of such ventilators has often increased the appetite, strength, and health of all hands in a factory. To have sweet air for all, 2,000 cubic feet should flow through hourly for each person. In some mines 6,000 is sent in, and the men work the better for it. Never crowd a room, for the air which will supply one man for five hours will only last 300 men one minute.



Ceiling Shaft.

Scrofula, or evil, and consumption, are much more frequent among those who live in close rooms in cities than those who have airy rooms, or who work in open air half the day. Many people bear bad air without feeling its hurt; but although a slow poison, it is a sure

one. The air of some damp places causes ague, which used to be common in these countries before drainage improved the soil. A running stream, or a line of trees which live on the gases so hurtful to man, cuts off the poison swamps from houses, which in such districts should be built high on piles.

XIII.—THE LIVER AND OTHER GLANDS CLEANSE THE BLOOD.

Blood, cleansed of carbonic acid by the lungs, casts off other refuse by the liver, kidneys, and skin. The liver, our largest gland, weighing 4 lbs., lies under the midriff, covered in by the right lower ribs. It is made up of very small masses, in which three kinds of vessels break up:—1st, arteries; 2nd, branches of the *portal vein*, which carries all the blood from the stomach and bowels; and 3rd, twigs of the vein which brings the blood from the liver to the heart, when ridded of bile. There are also tubes lined by cells, which have the wonderful power of choosing and removing the matter of the bile from the blood. The ducts bring the bile to the gall bladder, and thence to the first bowel, into which about a quart flows daily.

Bile is a yellow, soapy fluid, which, as we have seen at p. 30, acts on food. When the liver is sluggish, the bile kept in our blood causes jaundice; but when it ceases suddenly to work, death ensues. The lungs and liver help each other; and a man who has got bilious from sitting some days at work, gets all right again if he climbs a few hills, or walks ten miles. Such is a safer and pleasanter cure than blue pill and black draught. In India those who eat and drink too much and work too little, get big livers. The liver also makes a kind of sugar which gives us heat, and forms it even in animals who take no sugar or starch in their food.

Urea is a substance of which our muscles and brain throw into the blood about an ounce daily if they are at work. A man with idle muscles and a lazy brain would not form half that. The kidneys strain off this urea dissolved in water, and if they fail to do so, as in *Bright's disease*, it becomes a fatal poison, like opium or spirits. The brain also sends off, according to its work, much or little of salts, called *phosphates*, in this fluid. The kidneys lie high up on each side of the loins. They are made up of fine tubes, which take the fluid from the blood-vessels twisted round them. In the fatal disease called *diabetes*,

they draw off the sugar which then exists in the blood. The skin and kidneys help each other in cleansing the blood, and if the former be not kept healthy the latter will suffer.

Other organs naturally aid each other by working in turns.

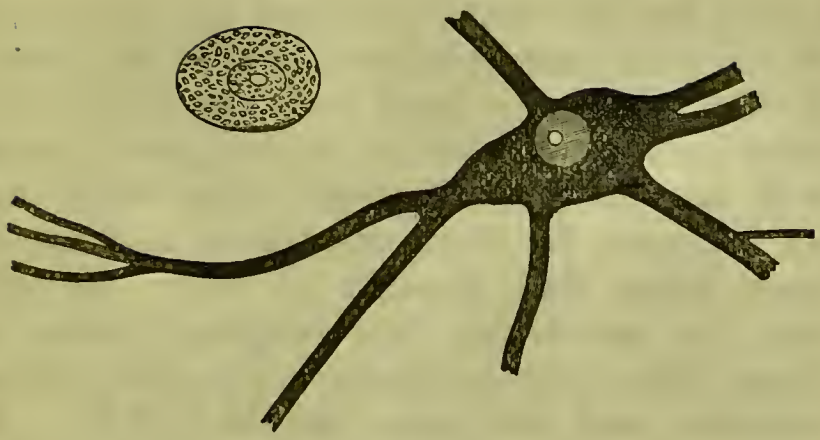
The spleen, *thymus*, and *thyroid* glands have no ducts to pour fluids into the passages of the body, but they act on the blood, which they get in very great quantity. The spleen, a spongy, red body, about the size of the hand, lies above and to the left of the stomach. Its vessels are large, and as blood flows freely between it and the liver and stomach, it may hold that fluid at times for them. Large cells in it are said to form the cells of the blood. The thymus is a fat mass behind the top of the breast bone of infants.

The thyroid, a body full of blood, lies across the top of the windpipe. We are not certain of the duties of either it or the thymus, but like the spleen they may renew blood cells. The swelling of the thyroid, goitre, so common in Switzerland and India, is thought to be caused by drinking hard water, that is, water in which lime abounds.

XIV.—THE NERVOUS SYSTEM RULES ALL.

To rule the parts described up to this there are nerves and swellings on them; and in the spine we have the cord, and in the skull the brain, for higher objects. This list shows you how hippish people err when they put their hand over their heart or stomach and tell the doctor their "nerves" are at fault.

Nerve-matter is of two kinds, white and grey; both are softer and hold more water than any other solid. It has albumen, fat, and phosphorus; the last being least in idiots and infants, most in adults, and getting less again in old age. It seems to vary with the brain's use, and hard study will throw it off freely by the kidneys. Our brain, to work well, wants food with these materials in it. The grey kind exists in swellings on nerves, the inside of the cord, and the surface of the brain. It is made up of *oval* or *star-like* cells, with a *nucleus*, and with tubes which are thought to make the nerves or white matter of the cord and brain. In large nerves hundreds of such tubes bundle together, but each tube being enclosed in another, goes to its destined point of skin or muscle alone. Nerve tubes



Nerve Cells.

loop in some places, spread out in others. Grey and white nerve-matters, then, differ more in structure than even in colour, and still more widely apart are their functions. The white merely carries a feeling from the senses or an order to the muscles, whereas the grey receives the one and issues the other. When we know that a candle is lit, or that a corn twinges, a message has been passed by the white nerves from the eye or the toe *to the brain*. If we want to blow out the candle, or pare the corn, a message must be sent *from the brain* to our cheeks or hands. How either message is sent we know not, but we say it is by nerve-force, which may be like muscle-force, a chemical change.

Nerve-force is, at least, a cousin of *elec-*

tricity, for the electric eel and ray give their shock by the masses connected with the brain; electric sparks may issue from the body, and, when dead, its muscles act by that great power as if the will directed them. The forces are not the same, for electricity travels millions of times faster than thought or will. At any rate the nerves are like telegraph wires, a *plexus*, like their crossings, a *ganglion*, like a sub-office, and the brain like the G.P.O. A break anywhere in the nervous or telegraphic systems, checks all. Cowper uses the poet's license when he says—

> "How fleet is a glance of the mind!
> Compared with the speed of its flight,
> The tempest itself lags behind,
> And the swift wing'd arrows of light."

Lower animals, a worm, an oyster, or a star-fish, for examples, have nerves and ganglions to order the parts by which their body is fed. Such are our "sympathetic nerves," and for a like purpose. If our brain were the only means we had to rule our grosser organs, no nobler thoughts than those of self could for a moment engage it, and it could know no rest. But the sympathetic nerves assist the brain in doing this humbler but necessary work. Those nerves, and the swellings on

them, the ganglions, lie along the spine, near the heart and stomach, and around vessels. In these last, they arrange the due amount of blood to flow, and the heat or growth which results. Worms in the bowel will make a child blind, and a blow over the stomach will stop the heart, and it is through these nerves the one part affects the other. If doctors knew what was "good for the nerves" they could cure many a *hysterical* girl, for in such these are out of order.

Membranes coat the brain and cord, one hard and stiff, another smooth, to make motion easy, and a third made up of vessels. The second is the seat of "water on the brain."

The spinal cord is about as thick as one's finger, and 18 inches long, reaching from the skull to the second loin bone. It is marked into two halves, and its grey matter lies inside. It sends off 31 pairs of nerves—8 in the neck, 12 in the back, 5 in the loins, and 6 to the haunches. Each nerve has a back root bringing feeling to the cord, and a front root carrying orders to muscles. Their roots mix, and they thus spread these powers through all the body.

The cord is a great nerve from the brain; if it is cut, therefore, say in the loins, the man feels no pain if his legs be hurt, nor

can his will move them. The feet of such a poor palsied fellow were tickled, and being

asked if he felt it, he said, "no, but you see my legs do," for they were kicking about.

Thus it was seen that the cord can receive feelings and call forth motions of itself. The brain of a sleeping child is at rest, but if you put your finger on his palm it is grasped at once, the feeling being brought to the cord, and the order for motion from it by *reflex action*, as we say. Feelings are also sent downwards; thus, if you hit the nerve at the elbow—the funny-bone—the little and ring fingers will tingle.

The oblong marrow, above the cord, is the most vital part, for it is connected by the 8th nerve with the lungs, heart, and stomach. Thick muscles in our neck protect it, but in the rabbit a slight blow behind the head is fatal by crushing it. The merciful, because quickest way to slaughter an ox is to pierce the skull with a spike, and then thrust in a rod to this marrow. A clot of blood or hurt to that part of the brain in which the cord spreads will *palsy* one side, generally the opposite, and this is more serious than when the legs only are palsied.

The lesser brain lies at the lower and back part of the skull, and is about the size of a small fist. It is thought to order such combined motions as those by which we dance, skate, or swim. If half of it be cut from animals they roll round for days, often 60 times a minute.

XV.—OUR NOBLEST PART.

Within the skull, a safe casket, lies a precious jewel, indeed our noblest part.

The brain is cleft above into two lobes, joined below, and its surface is much twisted. These *convolutions* increase the surface of the grey matter, and the powers which it has. Man's brain weighs about 48 oz.; that of a whale 75 feet long was 70 oz., much being made up by the lower part and nerves which come from it. In proportion to other parts the lobes of our brain are larger than those of any other creature. The brains of clever men have sometimes been very heavy; that of Cuvier, the greatest of *anatomists*, was 64 oz., and Lord Campbell's was 53. On the other hand, the brain of an idiot weighed but 20 oz. Mind in us, and instinct in animals, have relation more to the number and depth of the convolutions than to weight. These parts have no feeling, mind and will being their sole functions.

Thought, *memory*, *perception*, *will* and *consciousness* of our being, are the offices of the brain. The organ lives and dies, wastes and repairs, but something unchanging, undying, is superadded, namely, the Soul. As there are two lobes in the brain, ideas may in

a way be double; an idle boy might read his book and count his marbles in his pocket at once. He would learn nothing, however, and afterwards would not have the zest for play which the feeling that one's task is well done always gives.

Those who call themselves *phrenologists* say that each convolution has a special office, and pretend that the bumps on the skull, show how far each is brought out. But bumps are mostly mere thick points on the skull, and half our convolutions are many inches from any part of the skull which they could swell out so as to be felt. As Napoleon Bonaparte urged, most of the faculties these "professors" fix are not natural, and we cannot positively seat those which are. A high, wide forehead suggests a large mind, and kind, honest thoughts mark the face, so that there is some truth in both phrenology and *physiognomy*.

We sleep to rest the brain altogether, and other organs in some degree. Infants enjoy "Nature's soft nurse" for half the day, and no one thrives who does not thus rest eight out of twenty-four hours, those from 10 at night to 6 in the morning being the best. When you turn in bed, turn out, was a rule of the great Wellington. Too much sleep dulls one, and too little makes one

restless, or perhaps insane. Some common feeling may start ideas in a brain not quite at rest. Many a dream about a corpse or about being drowned has arisen from touching a cold iron bedstead. We sleep best if we lie on a firm level surface, like a mattress, in a bedstead without curtains, which shut out pure air.

Sleep-walkers have part of the brain in action, while other parts rest. *Mesmerists* can put weak persons into a like state, but as no good has ever resulted, do not spend your money on such quacks.

Education of the brain, as is the case with other parts, strengthens it. Its faculties are various, so should be its exercises; after a hard sum or parsing lesson, one enjoys a pleasant book, or a lecture about dogs or horses from the master. Memory is easily trained, and many Greeks could repeat the whole of Homer's poems. In childhood both brain and muscles are quickly moulded, and we learn the arts which make us useful and happy through life. That "knowledge is power" appears now-a-days most clearly, for it arms even the most humbly-born to win the foremost places in the battle of life.

The best time for study is the morning, when the brain is rested by sleep; silence makes its task easier, and bracing air and cheery sunlight

make it active. Food should be taken on rising, and then one may work an hour after. Early rising is the most healthful of all habits.

That our judgment and will shall rule our passions, is a grand aim of education. They have their seat in the brain, but the state of the digestive and other organs often influences them.

Temper also depends much on the health of the body, and we therefore have good reasons for mending our own, and for bearing the crossness of others. Ill humour not only hurts oneself, but all others in the house, for it is a "taking disease." While, with good humour we enjoy meals, work, play and sleep, and we hope that our fellow-beings may be as happy. Next to a good conscience a good temper tends to give long life. A healthy mind in a healthy body will never think of that saddest of crimes—suicide, for

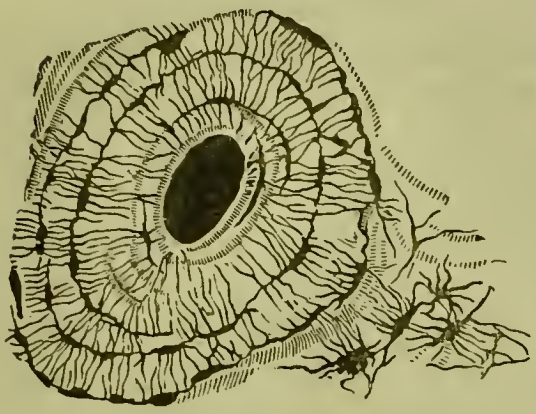
> "Whatever crazy sorrow saith,
> No life that breathes with human breath
> Has ever truly longed for death.
>
> "'Tis life whereof our nerves are scant;
> Oh life! not death, for which we pant;
> More life and fuller that we want."

XVI.—OUR BONES AND JOINTS.

Animals are best marked from plants by their power of moving from place to place. The brain and spinal cord direct the motion of the parts we now will study. The skeleton or framework of the body (see page 8) is made up of 206 bones, most of which move at joints. Bones are hollow, and combine lightness and strength, the space being stored with marrow. This fat may re-enter the blood as heat food, and being fluid it saves bones from hurt. They are hard or spongy, according to the pressure they are meant to bear, but everywhere their *mechanism* is perfect. For instance, the skull to protect the brain is arched, made of two hard plates, with a buffer between, and with their edges locked together by "dove-tail;" and to break shocks from it our spine is curved, and made of 24 bones (*vertebræ*), with springy pads between them.

The structure of bone is beautiful, and so distinct in various animals that a microscope, with a bit not heavier than a hair, will tell which it belonged to as surely as if its owner came back to claim it. This view of such a bit, cut across out of man's bone, shows one of the canals which pass lengthwise, little spaces

and very fine tubes which join them. All of



Bone, as seen under the Microscope.

these soak blood from the inner and outer coats of the bone, and the hard stuff is laid in layers. A child's bone has gristle between the ends and middle part to let it grow long, and it grows thick in rings like a tree. The ends may snap off, and in children who do not get milk, or such good food, the bones bend, the disease being called *rickets*.

Gelatine forms one-fourth and earthy salts three-fourths of bone, save in children, when there is half, and old people when there is one-eighth of the gluey matter. A burned bone is black from its carbon (charcoal), and brittle, while a bone steeped in acid, losing its hard salts, can be twisted into any shape. The salts are chalk and phosphates, which, when taken from cattle, the farmer values as

manure. They are carried from the food through the blood to the bones.

Fibrous tissue, in strong bands of a silver tint, ties bones together and forms sinews, in which muscles end. The rope of it above the heel will bear 1,000lbs. weight. Yellow fibres exist along the spine, the arched soles of the feet, arteries, and other places where spring is wanted. Both these kinds of threads mix in the spongy mesh round muscles, under skin, and in fact everywhere through the body. It is this tissue in a poor joint of veal which the butcher puffs up. Our fat, held like oil in little cells or bags, lies in it.

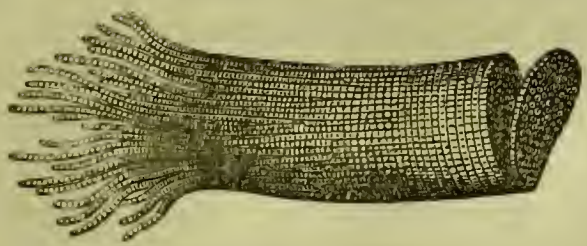
Cartilage, or gristle, in tough sheets forms the ear, nose, and windpipe, and gives the ends of bones a smooth surface. It is springy, and thus the weight of the body flattens it, and we are therefore half an inch shorter at night than in the morning. Very old people stoop as the gristle of the spine becomes flat and stiff.

Joints are made still more slippery by a membrane with a shiney fluid, which acts like grease round an axle. Such membranes also coat the lungs, heart, brain, and bowels, as well as the cavities in which they lie, their use being to make movements smooth and easy. The elbow only moves to and fro like a hinge; the hip and shoulder, like a ball and socket, move

every way. We can bring the arm to and from the side, forwards and backwards, and roll it round, and the shoulder being so movable is oftenest "put out of joint." *Atmospheric pressure* keeps the thigh-bone in its socket, for if air is let in by a pinhole down drops the loose leg, and our limbs feel weak on mountains, as the air is so light. One bone of the forearm rolls round the other, as we see when working a gimlet. The skull moves on the spine by joints so beautiful that there is much evidence of design in their structure. They are so delicate and near such vital parts that lifting up a child by the head may be a fatal trick.

XVII.—OUR MUSCLES.

Bones cannot move of themselves, but are acted on by the muscles which are fixed to them by *tendons*. Muscle or flesh is made in threads, each of which is like a string of square beads, the cross marks being only on those



Enlarged view of Muscle.

which obey the will. Each thread and the whole bundle is clothed by a fibrous sheath, which goes beyond it and forms the narrower tendon. The tendons are kept in place by fibrous tissue, which forms tight bracelets round the wrists and ankles. At least 400 muscles may be counted in the body. Blood most freely flows to muscles, and its oxygen burns their substance, and causes shortening, their useful and peculiar power. When the arm is straight, the muscle in the thick part, called the *biceps*, is about twelve inches long, but it gets four inches shorter as it bends the forearm to the mouth. In shortening it gets stouter, as we can see under the skin, but yet loses bulk, for oxygen has burned some of it into water, carbonic acid, and urea.

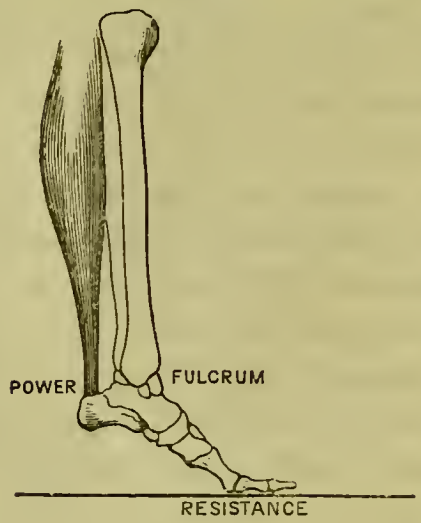
Although muscle has such wonderful power during life, it will not bear after death as much strain as fibrous tissue. Muscles pull in the direction of their threads; the longest in the body can bend the leg on the thigh, and raise and cross the latter. As tailors must use it much it is called *sartorius*. In fan-shaped muscles the front, middle, and back threads pull in various ways, thus that of the temple seen on page 68 can move the jaw forwards, upwards, or backwards. Muscles are placed in sets, some of which may pull against others,

like the top and bottom men in a sawpit, and others change their force by passing through a pulley, like one of those of the eye. Action tires muscle, or rather the nerves which supply it. Muscles cannot act without giving sensations of more or less fatigue, and long after, we can remember and compare these sensations. If I lift a weight or overcome a resistance now, I can compare the sensation with that which I felt yesterday on lifting a different weight or overcoming a different resistance; and hence the power of measuring the resistances of bodies by the sensation which I feel in overcoming them. This power, called *muscular sense*, is as useful to man as the other senses, and teaches us how to stand or move. Habit makes a butcher guess closely the weight of meat by this power.

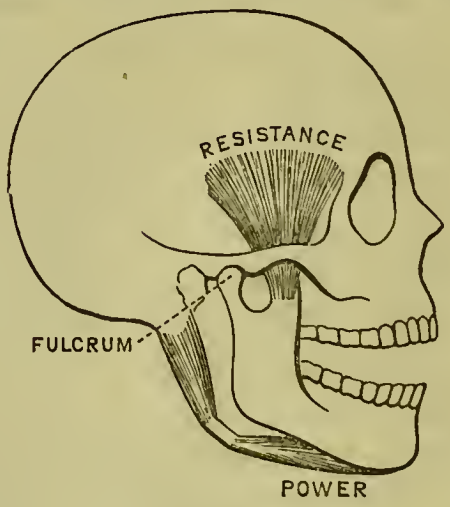
In the stomach, bowels, and some other organs there is a pale, wavy kind of flesh, and it is beyond control of the will. Both those muscles within control of will, and those beyond it are subject to sudden action or *spasm*, and lock-jaw and cramps in the bowels are examples of each.

The levers are much used in our motions. The first order comes into play when we rise on tiptoe, the calf is the *power* at one end, the ground the *resistance* at the other, and in the

middle is the ankle-joint, the *fulcrum*. It

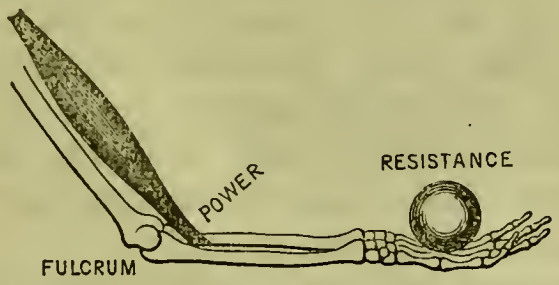


would be better to regard the ground as the fulcrum, and then it would be of the next



order. The second is in force when the muscle below the jaw opens the mouth; this

muscle, called the *digastric*, or two-bellied, is the power, the joint the fulcrum, and the resistance, in the middle, is the *temporal* muscle which tends to keep the mouth shut. When we lift a weight in the hand we use the



third order; this ball is the resistance, the elbow the fulcrum, and the power (the biceps muscle) acts between the two other parts of the lever. The third is the most frequent lever, as quickness of motion is gained at the expense of quantity moved. The fingers of a lady playing the piano or those of a printer setting type move so fast that we can scarcely see them move.

Standing erect has been treated of at page 7. The *centre of gravity* is just below the loins, and a line dropped from that falls within the *base of support*—namely, the space between the feet. If a drunken man runs he keeps his centre of gravity over the base of support, and is less likely to fall than if he

walks. A hurt to the brain or cord (*concussion*), or weakness of the heart (*fainting*), makes one unable to keep the erect posture.

Walking is done by bending the knee and stretching the foot. That leg being thus raised, the weight falls on the other limb, which in its turn rises from the big toe and throws the body forwards on the leg first moved. All should aim at grace in walking; keep the shoulders well back, the arms bent, the loins slack, and throw the legs straight out in time with the arms.

Running requires quicker movements, with the body bent forwards; and in jumping we raise both legs at once from the ground.

XVIII.—WORK AND PLAY.

Exercise of muscles is quite as important as that of the brain, and both are improved by training. Disuse of a muscle would lead to its loss, for in a few months it would change into fat; while use increases its blood, and therefore its power, as we see in the smith's arm. The lungs, heart, and liver act best while muscles are working; for instance, a man riding or walking fast, breathes four times as much air as one lying still.

The mind, too, becomes free and joyous,

the more so if the work be in the open air. Hale, hearty, and therefore happy, is he who earns his bread by the sweat of his brow:

"Who only asks for humblest wealth,
Enough for competence and health,
And leisure, when his work is done,
To read his book
By chimney-nook,
Or stroll at setting of the sun;
Who toils, as every man should toil,
For fair reward, erect and free;
These are the men—
The best of men—
These are the men we mean to be."

The labourer is free from *gout*, for which Abernethy's cure was, "Live on sixpence a day and earn it."

The spine suffers most from want of exercise, as we see in girls whose stays and stooping posture over a desk keep stiff. The skipping-rope for an hour, or a two hours' walk, daily, would keep them from getting crooked, and make all their movements more light and graceful.

Factories, up to 1835, used to make children who worked in them sickly and deformed. Since then inspectors see that they have good air, fair hours for work, rest, and education in turns, so that earning and learning go hand-in-hand. Like rules are now in force for workshops where more than five

persons are employed. The baker should be freed from night work, and the miller and metal worker saved from breathing the dust of their trades. Printers should frequently wash their hands, in order to avoid taking in lead from the type; and *mirror* makers should do the same, and only work now and then, for the *mercury* they use is most hurtful. A better and a cheaper looking-glass can be made with silver, and no harm comes to the maker.

Cricket for boys, and croquet for girls who work indoor, are the best games, and schools should have vaulting bars, chest-pulls, swings, or other ways of exercising, when the day is wet. Young people who assist their parents in the field get the best kind of exercise. Efforts, if too sudden or violent, may burst our vessels, or cause rupture. Exercise should cease if hurried breathing comes on, and should never be taken too soon after eating. As to dancing no one can find fault with that which is modest; it trains the ears as well as the muscles, and gladdens the mind. Healthy games keep boys from cruel sports against harmless animals, and girls from pride of dress, the evils which most beset each.

Boys who want to be always learning can explain the first order of levers while on a see-saw, or the second while pulling an oar.

Parks may be made and paid for out of the taxes of all towns, and they should be central, else working people cannot use them during short breaks. There should always be a tea-house and concert-hall, where people may enjoy themselves on summer evenings. Good conduct in parks and public gardens must soon overcome those selfish persons who try to shut up squares, seaside paths, and pretty walks. Those who have learned something of natural history will find fresh pleasures in every country stroll.

XIX.—VOICE AND SPEECH.

Many animals make distinct sounds in the voice-box at the top of the windpipe, but we alone have speech, a gift next in value to reason.

The larynx, as the organ is named, from being like a whistle, is made up of four pieces of cartilage, the largest, Adam's apple it is called, shielding the others. It is shown on page 33. The smallest of these pieces are moved by many muscles, and have fixed to them the vocal cords. These two cords, nearly an inch long, close in front, and a very narrow chink is left for the air to pass in and out.

The air passing out makes them *vibrate* like the strings of a fiddle, or, as they are so short, more like the tongues of an accordion. If the cords are held tight by muscles, they vibrate quickly and give a high note; if they are loose, slower movements give a low note. The tenor and bass voices, and the tones of the boy and man, depend on the length and spring of the cords, and the power of the chest to force out air. Raising the chin tightens the cords, lowering it loosens them, and these are among the changes we make as we sound high and low notes.

Speech is produced in the mouth by the aid of the lips, tongue, and palate, which modify the voice. Vowel sounds depend on the size of the mouth as they issue; for instance, it is five times larger when we sound *a*, as in *ma*, than when we sound *oo*, as in *cool*.

Consonants are sudden, like *b* and *d*, or continuous, as *l* and *s*. *Labial* sounds, as *b*, are caused by quickly parting our lips; *dental*, as *d*, by pressing the tongue against the teeth; while *linguals*, as *l*, mainly depend on the tongue. Surgeons have cut away the tongue from persons who yet have spoken pretty clearly afterwards; so that losing one's tongue is not always the same as to lose one's power of speech.

The child gains speech slowly, first learning to pronounce the vowel *a*, the consonants *b*, *m*, and *p*, and their unions, *ba*, *ma*, and *pa*.

Voice and speech show most perfect motions; 400 words may be pronounced in a minute by rapid and faultless actions of their muscles. Usually, however, we do not utter more than 100 words in a minute. The best public speakers speak slowly, and their hearers have mastered one idea before another comes.

Stammering depends, not on faults of the muscles, but a want of due control of the mind. When a stammerer is not too conscious of his fault and tries to form his words slowly he speaks plainly, and may sing well, for then his words must come in time.

Many persons who stutter in common conversation, can speak with perfect fluency when making a speech.

Singing and reading aloud exercise our voice and speech, and fill the lungs.

Of the joys of musical notes our poet says:

"When thro' life unblest we rove,
Losing all that made life dear,
Should some notes we used to love
In days of boyhood meet our ear,
Oh! how welcome breathes the strain!
Wakening thoughts that long have slept;
Kindling former smiles again
In faded eyes that long have wept."

XX.—THE FACE, OR INDEX OF THE MIND.

Nine pairs of nerves come from the brain, and eight of these spread only to the face; that which is counted the eighth wanders very far. The 1st is the nerve of smell, and the 2nd that of sight just now to be studied. They start more truly from the brain itself than any others, and through these senses the mind and its power of memory are most easily reached. The 3rd, 4th, and 6th pass alone to the muscles of the eye, and by their actions that organ can help in the expression of many of our feelings, for instance, the downcast eye shows when one is humbled.

The whole face gets common feeling from the 5th nerve, and it is that which aches when we have *neuralgia* or toothache. It quickly carries feelings to the brain and cord, so that if water is dashed on the face of fainting persons they soon recover by the message "draw in air" being sent to the chest. Another part of the 5th rules the movements of our lower jaw, and it and a part of the 8th, are the nerves of taste. The 7th nerve has two parts; one we will shortly learn is the nerve of hearing, and the other moves all the muscles of the face.

Expression of such feelings as joy and

sorrow, love and anger, depends on small muscles, a few of which are shown on page 36. For instance, those marked 5, 6, and 8 would raise the mouth and denote joy, those marked 10 and 11, would pull it down and give a sad appearance. The habitual use of the one set or the other will stamp on the face the marks of either feeling and give us a pleasant or a sour countenance The nerve which works all such muscles is shown on page 56. If it is palsied on one side there will be a blank, while the other side will laugh or cry, and the whole face will look funny indeed. There were some cruel people in the middle ages who used to cut the nerve and deform children's faces in this way, for the purpose of making money of them at shows. The 7th nerve goes also to the gland which pours out the tears, and thus it makes us weep while we show a face of sorrow, by making more tears than the duct to the nose can carry off. Surely so grand a part as the face should be always clean, and then it will be fit for a kiss from mother or the mistress.

The 8th nerve has three parts, one to the neck, another to the tongue and throat, and the third (as shown at page 56), wanders as far as the voice-box, heart, lungs and stomach.

The 9th and last nerve moves the tongue.

All the parts which the brain and cord con-

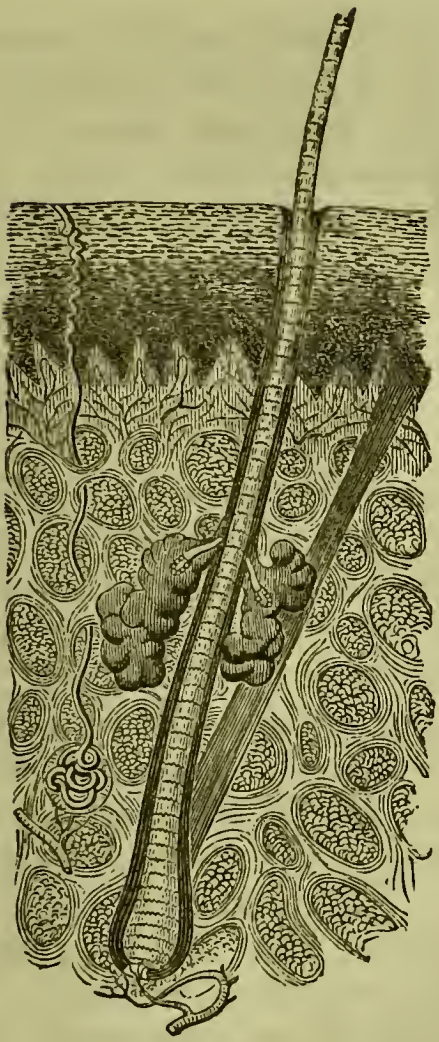
trol work in beautiful harmony; for instance, see what happens as one reads aloud. His mind is fixed on the matter of the book; this is held at the right distance, the eyes follow the print and carry its image to the brain, the muscles of the throat and mouth by speech, those of the face by expression, and those of the hand by gesture, tell others the ideas of the writer. As a lady reads and plays a piece of music and sings, a still greater number of acts are performed.

XXI.—THE SENSES—THE SKIN.

Upon the face are seated four of the organs of the senses, taste, smell, hearing, and sight. The fifth "gateway of knowledge," touch, is shared by all the body, and it we will study first

All the parts of the great organ of touch—the *Skin*—are shown in this diagram.

A blister shows that skin has two layers; the one raised by it is dry, and as it has no feeling we can cut it like hair and nails without any pain. This layer, called the *cuticle*, is thin on the face, thick on the hands and feet according to pressure. The deep part of it is moist, of a light brown tint in us, and black in the negro. Scales are always coming off



Section of Skin.

the cuticle, those from the head being called dandriff. This surface skin is a varnish to keep in moisture, and keep out dirt, and it blunts the feeling of the next layer.

Nails continue from the cuticle to protect the

nerves of the fingers and let them grasp small objects. They must be cut and kept clean.

Hairs also grow out from this layer, their roots being fixed in deep pits. Horny scales make the hair outside, and within is a soft pith which can soak nourishment from the blood. We cannot tell how sorrow made the hair of Marie Antoinette white in a few hours. There is sulphur in hair, and on it act all dyes which contain sugar of lead. Dyes are dirty and unwholesome, and as the tints are too dark, as the ends grow out white, and as wrinkles tell the age, the dye deceives only those who use it. A hale old man may be proud of grey hairs, for his many years, if well spent, are an honour. Hair grows most by day and in summer. Cutting hair strengthens it, and tends, along with the use of pomades, which contain a little Spanish fly, to prevent baldness. Wigs have been given up by sensible people, but others have taken to wear them, not on the head, but behind it. Shaving is a sore and time-wasting habit, and it robs us of a natural ornament, and of a safeguard of our throat from cold and our lungs from dust. A cold wind will make the muscles of hair erect them, so that our skin gets rough like that of the goose, and fright makes the hair of the head stand.

The cutis, or hide, as that from animals is called, is tough, yet elastic; the more so near joints, to let the skin stretch. When tanned its gelatine makes leather, that of the ox being the stoutest, that of the kid the softest. Below it blends with the fat or muscle, which may lie next. Capillaries and nerves weave so closely that the finest needle would wound them, for it lets out blood, and gives pain. Cold empties these vessels and drives blood to the lungs or kidneys, and thus draughts and wettings are apt to hurt these organs.

If the cutis is raw, poisons easily enter the blood, and thus quacks who promised to cure *cancers* have often killed their dupes with the *arsenic* they use. In order to vaccinate, the cuticle must be removed, and this layer saves us from taking in many catching diseases.

The nerves of the skin end in little points called *papillæ*, which are most numerous in the curved rows you can see at the tips of the fingers where touch is most perfect. The palm has less feeling, luckily for the boy who gets a pandy. These papillæ let us judge of the smoothness or heat of bodies with wonderful skill, and as they tell us of many things hurtful they are real body-guards.

If another sense is lost, touch improves from our making more use of it; thus the

blind can easily tell one little raised letter from another.

The glands of skin are of two kinds:—

1. *Sebaceous*, which pour out an oily stuff to keep the skin soft and pliant at the joints, and water-tight. They are most numerous on the head, and they oil the hair enough, without the nasty grease some people use. The palms and soles have none of these glands, so that water is easily soaked in. A mass of this greasy stuff may be squeezed from the nose, and as it is tipped with black dirt it looks like a worm.

2. *Perspiratory.*—Little tubes, a quarter of an inch long, but rolled up many times. There are three millions of these in one body, so that their whole length is nearly 28 miles, and no one can doubt that this system of drainage should be kept in order by cleanliness. As these glands are most easily affected by weather, we should do everything to make the skin hardy. The sweat they pour out contains salt, some acids, and water, and it is so plentiful that even when not dropping from the skin, $1\frac{1}{2}$ oz. goes off every hour. In summer we perspire most, while less water goes off by the kidneys. Men working in foundries and gas works often lose 3 lbs. an hour, and should get some good drink, like gruel, as then no harm results, for sweating of itself is not weakening.

XXII—COMFORT OF CLEANLINESS.

Some animals air the blood only by the skin, and with us it is like a third lung. A rabbit shaved and varnished died in a few hours, cold and smothered, and this hints that waterproof clothes do us harm. Other animals show us the good of being clean—a badly groomed horse is never sound or spirited, and a dirty pig puts up one-fourth less flesh than a clean one. Yet it may be feared that some human beings are only thoroughly washed at birth and at burial.

The cast cuticle, dried perspiration, and dust form a crust over the body of one who never takes a bath—the pores of the skin being thus choked, the blood goes in excess to the lungs and kidneys, and disease surely follows. Soft water and common soap are needed to dissolve this crust, and should be used on the hands and face thrice daily, as they soil so easily, and over the whole body at least once a week. Hard water wastes soap, and cleanses badly.

Cold baths drive the blood from the surface, and the *reaction* which follows when we rub with a coarse towel does good. Every one should daily wet the whole body with a sponge or bit of flannel, and then rub it dry

and red. Nothing is so good for improving the complexion, preventing colds, keeping up strength, and lengthening life. Five minutes are enough for this bath. If the habit is begun in winter, or in the case of weak persons or babies, *tepid* water may be used, but a tub of cold water is the thing to make a man hardy.

Sea bathing is delightful, the fresh air and bright scenery doing further good. We should go in while warm, and never till two hours after food; should only stop in a few minutes, for fear of being chilled or cramped, and should warm ourselves by a quick walk afterwards. Some persons can stay much longer in the water than others without being perished. The sign that you have not stayed in too long is that your skin is red when you come out.

Hot baths, of water or air, clean the skin most fully, and are good once or twice a month—85 to 90 degrees is the heat for a tepid, and 95 that for a hot bath. In the hot air, or Turkish, bath, a mass of cast skin, almost as big as the fist, is often rubbed off in the sweating room. This bath should not be taken without a doctor's advice, as the quickened action of the heart might do some persons harm.

Cleansing the skin is the best way to keep

off diseases of it, and of the lungs and kidneys, and rheumatism.

Paints and washes, instead of making people "beautiful for ever," soon make them uglier than before, and mark them as silly and vain fools seeking admiration and getting only ridicule.

XXIII.—CLOTHES.

Most clothes keep us warm as they prevent the heat of our body escaping into the air, but hats and turbans act in another way and shade off heat and light. Flannel and cotton, or merino, a mixture of both, are the best things for inner clothing in this climate. The receipt for rearing healthy children, given by John Hunter, the greatest of English doctors, was "plenty of milk, plenty of sleep, and plenty of flannel." Old people also want flannel, for their bodies cannot make as much heat as those of middle aged folks can. That we want warmer clothes in winter we learn not only from our own sensations, but from the thicker coats of animals at that time. We are more apt to catch cold on the back than front of the chest, because the air-tubes are nearer the surface.

Inner clothes should be changed at night,

and a clean set put on thrice weekly. The perspiration and oil of the skin soils them, and if we are dirty we lose the respect of our friends and our self respect. The moment we get up, our sheets and bed should be exposed to air and purified for some hours. All this may be called "too much trouble," but those who prefer to be dirty and lazy must take the risk of disease, and perhaps their death into the bargain.

Skirts, if too wide, may give colds, and if too long they trail and get dirty, and are apt to catch fire. As hundreds of deaths are yearly caused in this way, all cottons should be dipped in solutions of alum, and then they will not go on fire.

Stays, we have said before, prevent full breathing, squeeze the liver, and drive blood to the nose and limbs, and they make the figure as unlike as could be, to the statue of the Goddess of Beauty. Tight neckties check the flow of blood to the head, and may bring on apoplexy. Hats should be light and airy, and have a broad leaf to keep off sun. If too tight they make us bald, and if too heavy give headaches. The Tyrolese are the best, if not spoiled with feathers and other vanities unfit for men to hoist.

Shoes, if tight or ill-fitting, give us corns,

or make the nail grow into the big toe. A man thus lamed cannot go through his work well, and health soon suffers. Shoes should have a low broad heel, a straight inner edge, and a square end to let the toes spread, and to make sure of this the measure should be taken when the foot is pressed on the ground. They should fit so easily, that when first put on, the wearer hardly feels them on his feet.

Thin and broken shoes do so much harm, that those who cannot afford sound ones had better go barefooted.

XXIV.—TASTE, SMELL, AND HEARING.

The tongue, we have seen, aids in the chewing and swallowing of food and in speech; but it is also the organ of taste. Papillæ, like those of the skin, crowd over it, and they start up when tasting, as you can see by putting some vinegar on a person's tongue. Scales come off as from the skin, and when we are ill they stick to the tongue in a thick fur.

One branch from the fifth, and another from the eighth nerve, pass to the tongue, and can be traced to the papillæ. They give common feeling as well as the special sense of taste. Things to be tasted must be dissolved in fluid,

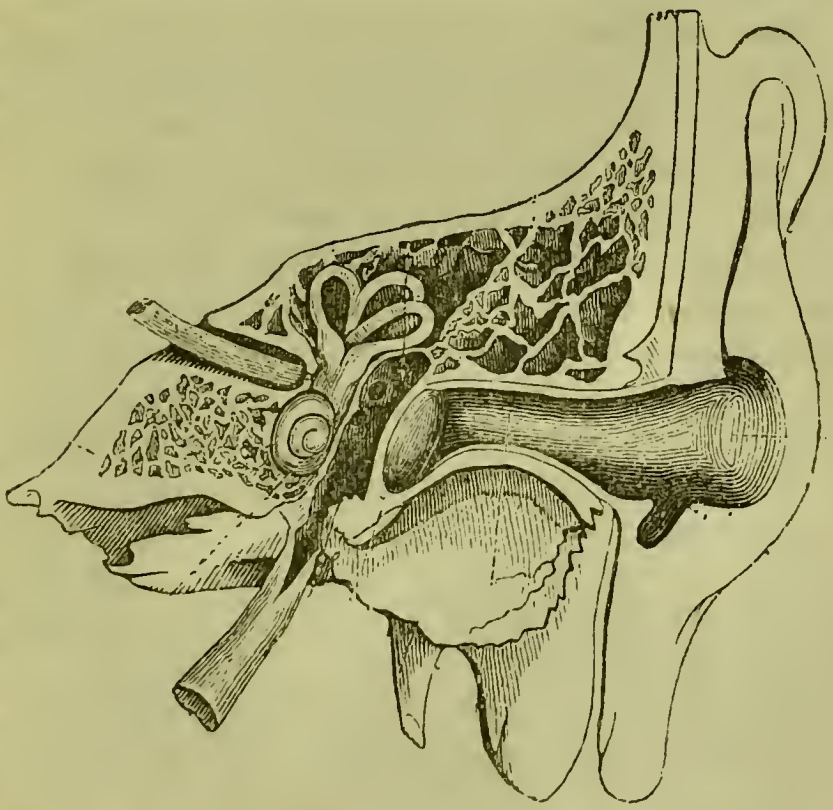
and the dry tongue when one is ill can scarcely tell one kind of food from another. Smell aids taste, so that a dose is made less nasty by holding the nose. The skill of those who judge teas and wines show that the sense may be highly trained.

The uses of taste are to warn us of bad food or dangerous drugs, which are usually nasty, and to give pleasure to the act of eating, for without it we might not go to the trouble, and illness should result. This pleasure, however, should not lead us to excess. Dainty and greedy persons should never forget that we eat to live, not live to eat.

The nose is the organ of smell, and does good work besides, in warming the air for the lungs. A clever book, with the queer title, "Shut your Mouth," shows that breathing only through the nose would save us from many a cold. The nose is made of gristle and bone, and is double like the eyes or ears. The cavities behind are large, crumpled, and lined by a moist membrane to fix the atoms which bring odours. It is kept moist by the tears which flow in by a duct. The first nerve, or nerve of smell, supplies only the upper half of the nose, so that we must sniff up air to smell well. A cold makes the nose at first too dry, and then too wet, and at neither time can we smell.

The uses of smell are to let us perceive pleasant odours, and to warn us of bad air, but habit often makes people bear the latter. Those living in pure country air can smell, and indeed see and hear, better than town-people. Some animals have a stronger sense of smell than man, and some bear bad smells patiently.

The ear has three parts, which may be



learned from this picture, the outer, the middle, and the inner ear.

The outer ear is a sheet of gristle, curiously folded for catching sounds. A tube nearly an inch long then carries them in, just as the ear-trumpet does. At the bottom of this tube there is a membrane like the skin of a drum, and it is kept soft by fluid wax. The wax sometimes gets hard, and if not taken away by a scoop, or by squirting in water, it may cause deafness.

The middle ear is a hollow in the bone, with a tube from the throat bringing in air. When a cold blocks the tube we hear badly, for the drum cannot *vibrate* to the waves of sound. The middle ear is shut from the outer by the drum-membrane, and from the inner by two smaller ones, a round and an oval. Three little bones, called the hammer, anvil, and stirrup, from these objects, stretch from the drum-membrane to the oval one. They carry sounds, and are made tight or loose by muscles.

The inner ear has three *semicircular* canals, a porch where they join, and the *cochlea*, so called as it is twisted like a snail-shell. Each canal contains a soft tube on which the nerve spreads out, and which has fluid both inside and outside. The oval membrane to which the stirrup bone is fitted shuts the canals from the middle ear. The cochlea has two spiral tubes, with the nerve spread on

the partition. It gets vibrations from the round membrane of the middle ear, and from the bones of the head. Whence sounds come, their loudness, pitch or quickness, and musical order, the inner ear judges—of the first by its canals, of the rest by the cochlea.

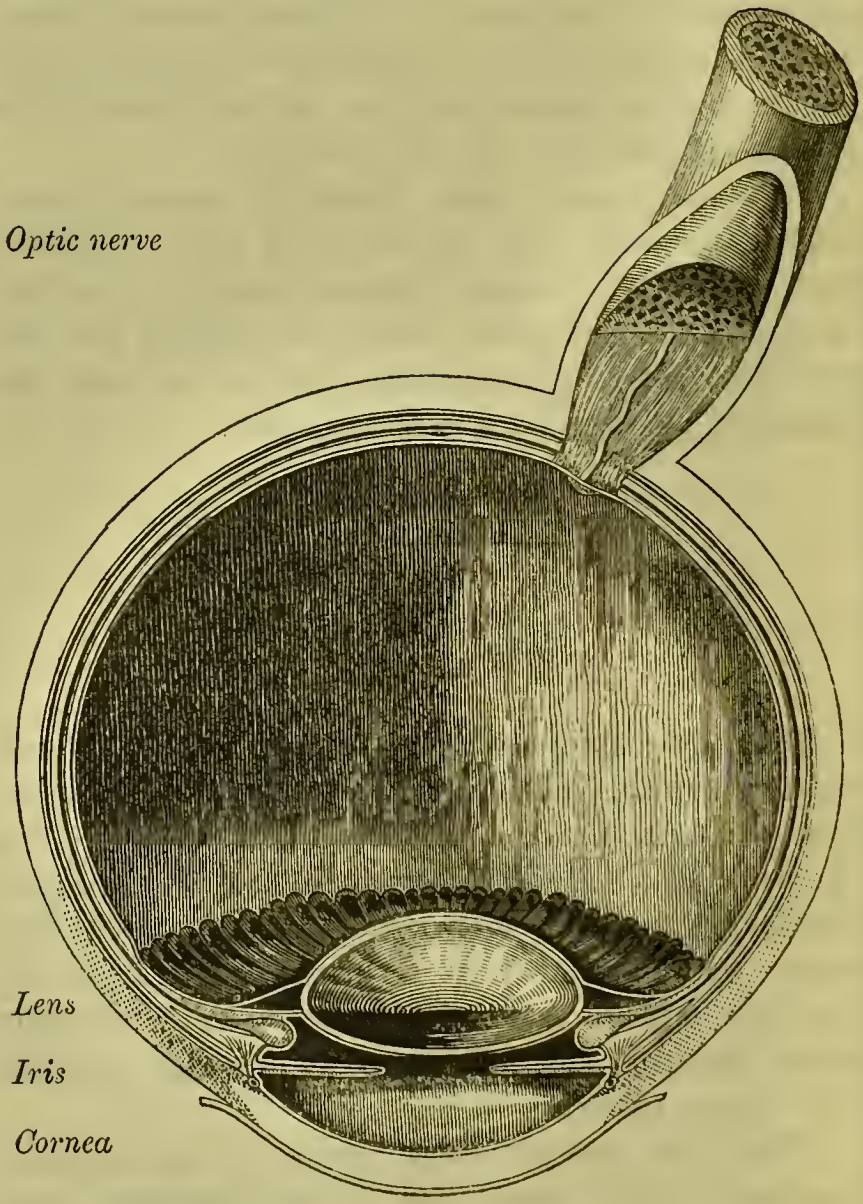
Sounds travel fast through water, faster through solids, but in air only go a mile in five seconds. Light passes nearly a million of miles in the same time, so that if we see the lightning three seconds before we hear the thunder, we are at a safe distance.

XXV.—SIGHT.

The eye exceeds in beauty of structure all other organs. This picture shows its parts, but we can learn them best on the eye of a sheep or ox. It is lodged in a bony hollow, the orbit, padded with fat, has six muscles to move it in every way, is guarded in front by the lids, and is washed by the tears. During sleep the lids, like shutters, are closed, and the eye turns upwards for safety.

The eye would be a globe of an inch in *diameter*, but that the front projects and

makes it an inch and a sixth from that to the back.



The coats of the eye are in three layers—First: The *sclerotic*, or white, a tough case with holes for nerves and vessels. The *cornea* or window is fitted like a watch glass into its front.

Second: The *choroid*, made of vessels and a black lining, to absorb the scattered light. *Optical instruments* are blackened inside for a like object. Neither white rabbits or those persons called *albinoes* possess this black coat, hence their confused sight.

The choroid fuses into the *iris*, or coloured part seen in front. This is a muscle with a hole, the *pupil*, in its centre, and it lets in much or little light, as the eye wants it. When you turn your back to the light the pupil is four times as large as when you face it.

Third: The *retina* into which the optic nerve spreads out. Pictures of all we see are formed on its outer layer, which Dr. Jacob discovered. From this the nerve conveys them to the brain, and as some of its tubes cross to the opposite half of this organ the pictures from the two eyes give but one sensation.

There are four parts which let the light through:—

1. The cornea, made of five clear layers, the first passing over the white from the lids, and the rest being elastic to keep the right curve

2. The fluid behind this, in which the iris easily plays.

3. The *lens*, convex both before and behind. It is kept in place by the row of dark folds, seen in the picture, and is moved by a muscle. An opera-glass must be screwed longer or shorter as it views a near or a far object, but this muscle of the lens serves the purpose for the eye. Such a glass is also faulty by breaking light into its seven primary colours, but the layers of the lens and the other transparent parts correct their own errors.

4. The vitreous body, which is like a jelly, holds out the retina as a globe to catch the image.

The rays of light from an object are bent to a *focus* by the parts just described. Without the help of these parts we could only see things the size of the pupil. The retina receives the image of an object, say a house, upside down, for the rays from the top cross those from the bottom. The image, as the great Kepler first proved, may be seen on the back of a sheep's eye if the outer coats be cut off. Although reversed, we see it right in the "mind's eye."

Near-sighted persons have the rays too much bent, so that they fall in front of the retina; old people, on the contrary, cannot see

things near, from their lens not being convex enough to bring the rays to a point or focus. Concave spectacles serve the first by spreading the rays, convex the latter by bending them more.

We are constantly winking or shutting our lids, yet we see an object, for its image lasts some time on the retina, and if parts of it be quickly impressed they are joined together by the mind. These points are shown by that grand toy, the "wheel of life," which every school should have.

If, after having looked long at any object, we turn towards a blank wall, an image or *spectre* of it appears, and this fact accounts for many a ghost story. The colour of the image is always different from that of the object; if one is green the other is red.

Some persons cannot judge colours and are hence called colour-blind. A tailor who had this fault made up a blue coat with a yellow sleeve. If a railway guard mistook colours, awful mischief might ensue.

Other senses and experience aid the eyes as to the size and distance of objects, but how exquisite is the retina which takes in miles of a view from St. Paul's or Nelson's Pillar. How much knowledge and pleasure flow in on us through these matchless organs!

By noting the colours and shapes of plants, animals, and the clouds about us, we train our eyes, and many artists have been thus educated. Such beauties of nature give a constant joy, and every cottage should have round it flowers like sweet-pea or wall-flowers, which a few pence will buy. The green of his fields, the brown of his moor, and the ever-changing hue of sea, sky, and hill, make the mind of the islander quick and bright.

Too strong light, and looking at very small objects, often hurt the eyes. Lamps should always be above the level of the eyes. Sore eyes are common in Ireland from poor food and smoky cabins. The use of the one towel may spread this disease among children. The loss of sight is so sad that none but the most heartless would torment the blind. The same may be said of the idiot, the mute, and others whom God has afflicted.

Hearing becomes more acute in the blind, as these lines feelingly tell us:—

"Alas, dear mother, that thou see'st me not!
But thou canst hear—and love
May richly on a human tongue be poured,
And the slight cadence of a whispered word
A daughter's love may prove;
And while I speak thou knowest if I smile
Albeit thou dost not see my face the while.

Yes—thou canst hear—and He
Who on thy sightless eye its darkness hung,
To the attentive ear like harps hath strung
Heaven, and earth, and sea!
And, 'tis a lesson in our hearts to know,
With but one sense the soul may overflow!"

XXVI.—LIFE AND DEATH.

The body weighing at birth about 6 lbs., grows to 140, our muscles, bones, and brain being mainly added to.

A baby should be laughing and playing, feeding or sleeping, all its time, for it wants more air, food, and sleep, than we do. Its face should never be covered with clothes, and, lest it should be lain on, a warm cradle is safer than the mother's bed. When nursed for nine months, cow's milk and bread and broth are good foods.

Spirits given to a baby, or, what is much the same, drank by its mother, is rank poison for the body, and it may be for the soul, by starting a habit which leads to ruin. Quieting drops are still worse, and are not wanted, for crying only shows that a baby is not rightly fed or clothed. Babies should be washed daily in tepid water.

They should not be let walk too soon, for

their bones are soft. As there are spaces between the bones of the skull to let the brain enlarge, great care should be taken of the head. These spaces, the growth of teeth fit for each kind of food, and many other points prove how carefully our future is provided for.

As we grow we increase in likeness to our parents, to whose teaching and example we owe so much.

Maturity is not reached till one-third of our life has passed. From middle life fat begins to load our organs, and when old age creeps on, our structures, being dry and stiff, seem to await the final event—death!

He who has kept his will and senses in check, and has loved and served his fellow-beings and his God, meets death without regret, and exults in the eternal future.

The heart, lungs, or brain, begin to fail in various modes of death, and fainting, want of breath, and deep sleep, point to each. Death may be presumed to have taken place when the beating of the heart, and the breathing and warmth of the body cease, and it is certain when the muscles stiffen, and corruption shows that "Dust thou art, and unto dust thou shalt return."

The story of the body given in previous pages is well told in Dr. Holmes' poem—

THE ANATOMIST'S HYMN.

"Not in the world of light alone,
Where God has built His blazing throne,
Nor yet alone on earth below,
With belted seas that come and go,
And endless isles of sunlit green,
Is all thy Maker's glory seen—
Look in upon thy wondrous frame
Eternal wisdom still the same!

"The smooth, soft air with pulse-like waves
Flows murmuring through its hidden caves,
Whose streams of brightening purple rush,
Fired with a new and livelier blush;
While all their burthen of decay
The ebbing current steals away,
And red with Nature's flame they start
From the warm fountains of the heart.

"No rest that throbbing slave may ask,
For ever quivering o'er his task,
While far and wide a crimson jet
Leaps forth to fill the woven net,
Which in unnumber'd crossing tides
The flood of burning life divides,
Then, kindling each decaying part,
Creeps back to find the throbbing heart.

"But warm'd with that unchanging flame,
Behold the outward moving frame,
Its living marbles jointed strong,
With glistening band and silvery thong,
And link'd to reason's guiding reins
By myriad rings in trembling chains,
Each graven with the threaded zone
Which claims it as the Master's own.

"See how yon beam of seeming white
Is braided out of seven-hued light,
Yet in those lucid globes no ray
By any chance shall break astray.

Hark, how the rolling surge of sound,
Arches and spirals circling round,
Wakes the hushed spirit through thine ear
With music it is heaven to hear.

"Then mark the cloven sphere that holds
All thoughts in its mysterious folds,
That feels sensation's faintest thrill,
And flashes forth the sovereign will;
Think on the stormy world that dwells
Lock'd in its dim and clustering cells;
The lightning gleams of power it sheds
Along its hollow glassy threads!

"O Father! grant Thy love divine,
To make these mystic temples Thine,
When wasting age and wearying strife
Have sapp'd the leaning walls of life;
When darkness gathers over all,
And the last tottering pillars fall,
Take the poor dust Thy mercy warms,
And mould it into heavenly forms."

XXVII.—HOW THE STATE CAN CHECK DISEASE.

The health of its subjects is one of the highest objects of a State. The plans for caring it differ much in each part of the United Kingdom; in England the Privy Council rules in this respect; in Ireland and Scotland the Poor Law Commissioners control country places, towns having no central guide. The offices should be made alike in

all, and the laws should be made into a system or code most clearly worded.

Town and country districts have always local boards, the following being examples of their names:—"The Vestry, St. Giles, London," "Health Committee, City Hall, Dublin," "The Guardians, Workhouse, Ballina," "Sanitary Committee, Glasgow." It is the duty of every one who sees anything likely to injure public health to report it to the proper board.

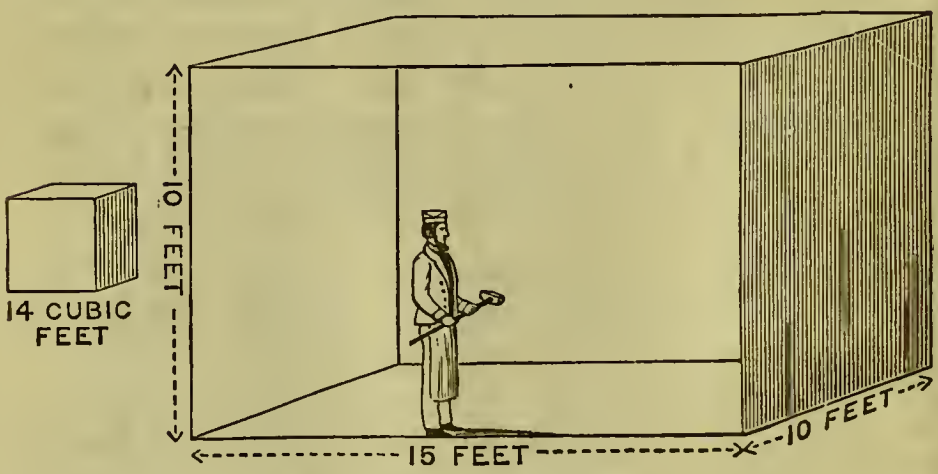
In 1864 many Irish towns were very badly cared for, but they are now somewhat better off.

Out of every 1,000 people in a country district about 18 die yearly; while out of 1,000 London persons, nearly twice as many used to sink some years ago. Now the rate is about 24, and thus the great works of that vast capital save thousands of lives yearly. Fevers usually carry off the heads of families, the rest being thrown into poverty, and the truth of Franklin's saying, "Public health is public wealth," is every day proved.

If the law for the registry of deaths were as good in Ireland and Scotland as in England, the ways of saving health and lives in each part of the United Kingdom could be compared.

"As is the home, so are the people," and "Out of dirt comes death," are true sayings, and it is the duty of the State to see that the poorest have decent houses, and that they are kept clean. How could ten people crowded into a dusty room in a dark narrow court be cleanly or good? And the smoky cabins or huts in which some country people are lodged would be as bad for them, save that they work half the day in the open air.

The Acts for granting loans to landlords for building labourers' houses have been little used, but the State will soon demand that all owners of the soil shall provide decent dwellings for their tenants upon it.



In many cities blocks of workmen's dwellings have been built, for instance, the Peabody

Buildings in London, and the Tenements Company's houses in Dublin In such the poorest man may have a healthier house than kings had a few centuries ago.

The very least space each person in a room should have is 300 cubic feet. This room is 15 feet long, 10 wide, and 10 high; these figures multiplied together give 1,500 cubic feet, so that five persons might live in it if air came in freely by windows and fire place. The size of a man, and of the amount of air he hourly breathes, is shown in proportion When people value fresh air more they will find 500 cubic feet the least space, or three people to such a room.

Great musty bedsteads often take up much of the space; iron ones are the most handy, clean, and wholesome.

The good points in a house are a high, dry, airy, and lightsome position, facing the east, with well built walls and sound flooring Dwellings should never be near stagnant water, in the midst of trees, or in other places where the wind cannot sometimes get at them. English towns have Building Acts to enforce such points, Irish towns have not, and houses are often placed back to back, a great cause of disease.

Drains to carry off rain and dampness of

soil, should be near every house in town or country, and the making of them has lessened ague and consumption. *Sewers* in towns should have a good fall, and be well trapped with water. A bubbling or hissing sound from them tells that poisonous gases are escaping. As sewers are spoiling many of our rivers, the refuse is now sometimes mixed with dry earth, or let flow over the soil, which is thus greatly enriched. Open cess-pits, dung-heaps, and foul pools near houses are disgusting and unwholesome.

Slaughter yards and cow-houses should be flagged and flushed with water, and as the filth soaks into the earth and injures the air, they, as well as all places where animal refuse is worked, are better outside of the towns.

Smoke from factories hurts the lungs of those who breathe it, forces people to keep their windows shut, and dirties our buildings. *Stokers* should always put the fresh coal at the mouth of the furnace, and let in air enough to burn it all. The persons in the neighbourhood would have more comfort, and much fuel would be saved.

Public baths and places for washing clothes with hot water should be built in every town. This might raise the taxes for a year, but they would soon fall, for these places would

spread cleanly, thrifty habits, and keep many a one from the hospital or poorhouse.

Burials should not be allowed in cities, for dead bodies send through the earth gases which hurt the living. The quiet country cemetery adorned with trees and flowers is the fittest resting place.

Insurance through the Post-office is the best way to provide for a decent burial, and some help for those who are left. The Post-office Savings Banks are the best in which to lay by some of the wages of a good season for bad times or sickness.

XXVIII.—CATCHING DISEASES.

Those who have catching diseases should be separated from the healthy. From 1345 to 1350 the "Black Death" killed one-fourth of the people on the earth, for in cities the sick were huddled with those yet healthy. Dr. Armstrong wrote:—

> "Infectious horror ran from face to face,
> And pale despair—'Twas all the business then
> To tend the sick, and in their turns to die;
> In heaps they fell, and oft one bed, they say,
> The sick'ning, dying, and the dead contained."

Refuges for the family of those struck down, are as needful as hospitals, for their cure.

During *epidemics* of fever or cholera, the rules are to kill their poisons by fresh air, and defy them by good food, cleanly ways, and a cheery mind. Crowding in a room where one has taken sick, robs him of air, and "wakes" often spread disease.

Small-pox, which every ten years used to kill more in Dublin than fell at Alma, has not caused one death in that city for the last two years. Vaccination then has had a victory. It is the duty of all parents to have their children when two months old vaccinated at the next dispensary, and to urge their neighbours to do the same. *Inoculation* with small-pox is an offence against law, as it spreads the disease and kills many.

Scarlatina lurks more in the room and clothes of the person who has had it, than any other disease. Airing the room and burning the clothes are the best steps. If the clothes are worth much they should be purified in the Hot Air Chamber of the town. Every town should have such a Chamber.

A child who has had this disease should not go to school for two months after, as he might spread it, and if he catches cold, fatal dropsy often follows.

Common fever, once our greatest scourge, has lessened as people have got better food,

better clothes, and better houses, and as they have learned that it is better to go at once to hospital.

Pure air is so great a *disinfectant* that in the famine fever of 1846 more of those who lay under hedges got well, than of those who lay in houses. Half a stone of *chloride of lime* should be spread and wetted on the floor of any room where there has been a fever, and the next day the room should be most thoroughly aired. As the seeds of plants and lowly animals can be seen by the microscope in air, it is thought that the germs of disease may be carried there too. By breathing through a mass of cotton wool, air may be filtered of all those particles which one may see in a ray of sunlight.

Bowel fever and cholera spread by sewage, and should be made harmless by throwing two ounces of *carbolic acid*, or *copperas* on all discharges. Soiled clothes should be put in boiling water. When the seed of cholera is brought into towns, it thrives in low, ill-drained places, while clean, well fed people escape.

Consumption mostly seizes those whose parents have had it, and those who have not had fresh air, good food, and dry houses. If the State could secure those blessings for all,

only 1 out of each 2,000 would sink yearly by this disease, which is the rate in some Scotch islands, instead of 10 in 2,000, the rate in cities. It is selfish to cause one's own sickness—giving trouble to friends, and perhaps cost to the country.

XXIX.—THE DOCTOR.

The State provides for the cure of the sick poor in various ways in the United Kingdom, but best in Ireland. The Poor Law Commissioners are the rulers, and a committee in each district issues tickets only to those who are poor, for all well-to-do people should pay for advice. With the black printed ticket the sick person goes to the dispensary, where the Doctor sits twice, or oftener, weekly. With the red ticket, if he sends early, he will have the Doctor with him at once.

The sick should always send early in the case, for life may be thus saved, but never unless there is need, and not too often, for the Doctor can best judge when the visit should be repeated. Districts include about 20,000 acres, and about 8,000 persons. For so much work the Doctor is not paid enough, and he should be further paid for efforts to

prevent disease. None but the Doctor should ever be the registrar of births and deaths.

The Doctor has a grand office, for he cares the human body which the Son of God deigned to assume and has promised to raise from the grave. The Doctor's kindness grows, as he sees more of sorrow, and his temper only fails with those too cross or fanciful. Choose a Doctor respected by others of his profession, for they can best judge his merits, and one who is least like the pests we have now to speak of.

Quacks, and those who puff their physic in the papers in many cunning ways, rob your money and your health. You should as soon let a cobbler mend your watch as a quack or bone-setter your lungs or limbs. Do not believe in charms, but rely on the means in which God has instructed mankind for the recovery of health. Only the Doctor can use these means well, and no one should ever take drugs without his advice.

To help the sick is the duty of all, and the poor seldom fail in it. Howard, the fearless lover of his kind, gave two safe rules:— "I never enter an hospital or prison before breakfast, and in an offensive room I never draw my breath deeply." A sick room should be airy, silent, and none should stay there but the nurse. She should be quiet, cheery, and

obedient to the Doctor's orders. The food of a sick man must be of a finer kind than that in health, and he wants it oftener. When the poor are so sick that they must take to bed, they cannot have all these comforts, and should therefore go to hospitals.

Of these good places there should be more through the country, with the best Doctors that can be procured over each. Hospitals in the suburbs, where the sick may recruit, and those which harbour the incurable, richly deserve public charity. The State could also do great good by sending trained nurses to every parish.

XXX.—WHAT TO DO FOR ACCIDENTS.

Mishaps reach us all, to check us, and show that this is a life of trial; but one is never more "a friend in need" than when he saves a fellow-being, it may be, ill prepared for death. If you learn the short rules which follow, and keep cool enough to use them, *and send for the Doctor at once*, it may be your good fortune to save lives.

Poisons.—1. *Acids*, as vitriol, spirits of salts, or oxalic; you will know them by their

having burned the mouth. Whiting, plaster off a wall, or soap should be mixed with water and given.

2. *Alkalies*, as potash, hartshorn, or lime, also burn the mouth. Vinegar, lemon-juice, or oil should be given.

3. *Arsenic* causes pain and sickness of stomach. Lime-water and milk, or magnesia, are of some use.

4. *Caustic or nitrate of silver* burns where it touches. It is made harmless by common salt.

5. *Corrosive sublimate* burns and destroys. Give raw eggs, milk, or flour.

6. *Lead salts* (*sugar of lead*, *&c.*), sicken the stomach and dry up the bowels. Give an ounce of Epsom or Glauber salts.

7. *Opium* (*laudanum*, *&c.*), brings on deep sleep. Give a table-spoonful of mustard every fifteen minutes, or tickle the throat with a feather till he vomits, then give coffee, and walk the person about.

8. *Plants*, *as nightshade*, *hemlock*, *or monk's-hood*, have often killed children foolish enough to eat what they did not know was good; they either sicken the stomach or stun the brain. Bring on vomiting (as just advised), then give powdered charcoal—soot, if none better be at hand.

9. *Prussic acid* throws the person in a faint.

Dash with water, and draw in air as advised below.

10. *Strychnia* kills by exciting the spinal cord and muscles. Bring on vomiting, and give half a pint of hot water in which a bit of tobacco the size of a shilling has soaked.

11. *Tartar emetic* sickens the stomach. Give strong tea.

The best safe-guard against poisons would be to allow them to be sold only in chemists' shops by Doctors' orders.

Gases in brewers' vats, wells, and manure tanks, may be got rid of by letting in air below, and by throwing in slacked lime. If a candle goes out, or even burns dimly, they are unsafe, and if a man goes down in such places he should have a rope round his waist, so that he may be hauled up if he gets ill. Dashing with water and drawing in air, as for drowning, are then the right steps.

Poor vagrants often lie round lime kilns for heat, and are killed by the carbonic acid gas. Some gas-works let lime refuse into sewers, and the gases sent from it may poison people, and dye the blood blue. The steps to restore them are those just stated.

Drowning, as we learned at page 46, kills by want of air in the lungs. Therefore the instant a body is taken from the water—(1)

clear the mouth, (2) pull forwards the tongue, and (3) draw the arms above the head, and then press them to the sides. Do this fifteen times in the minute, and go on for half an hour, for the vital spark may lurk thus long. Others may rub the limbs while the body is being carried to a recovery-house or hospital. There, warm blankets, hot bottles, warm drinks, or a bath will bring back circulation.

For one hung or strangled the steps are the same, the cord having been cut from the neck at once.

The throat may be plugged with food; the finger can hook it out if the tongue is pulled forwards. It may be scalded, if children get the habit of drinking from a kettle. Croup also quickly blocks the narrow chink between life and death. Half a teaspoonful of hippo and very hot stupes to the throat are the best remedies at hand.

Fainting or other fits are best cured by bringing the person to open air, laying them on the back with the head raised, and the neck and chest freed from tight clothes. Then cold water may be dashed on the face, and other people should not crowd round.

Burns and scalds should be covered with wadding, or the softest cloth at hand, and the person should be kept warm and get hot

drinks till the doctor comes. Clothes on fire are best put out by rolling the body in a blanket or tablecloth.

Broken bones should be kept in place by thin boards, bits of a bandbox, or sticks tied on. If the lower limb be broken, the body, with the legs tied together, should be carried on a door to the nearest hospital. Bones out of joint can be only treated by the doctor, but sprains and bruises can be served by applying a bit of linen kept wet with cold water.

Wounds should be washed with cold water, and then their edges should be drawn together by bands of linen or straps of plaster. Parts cut off may grow again, so they should be fixed on till the doctor comes.

The wounds made by poisonous animals, mad dogs, or snakes, should be washed, then sucked and touched with a heated iron. A tight band above the wound is also good. Spirits should be given freely. A drop of hartshorn will cure the bite of a wasp or bee.

Bleeding from the nose is seldom serious, except in old people. Dashing cold water on the face, and holding the hands high up will often stop it. Sores at the inner ankle may open the vein there, which then bleeds fiercely. The finger will stop it if the leg be raised high.

Wounded arteries jet out scarlet blood, and

so freely, that life may be lost in a few moments. If you press with the finger or a pad of linen on the cut part of those of the face, hand, or foot, you can stop them till the Doctor comes. If those of the arm, thigh, or leg are cut, fix a bit of linen rolled hard just above the wound, and bind it on with a handkerchief. This band may be tightened by putting a stick under it and twisting it round.

Sand in the eye should be got out by pulling down the upper lid by its hairs over the lower, which will brush it out. If you can see it take it out gently with the tip of the finger, or a bit of blotting paper rolled into a point.

INDEX AND GLOSSARY.

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